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ECOSYSTEM SERVICES AND SUSTAINABILITY EVALUATION OF ALPINE DAIRY CATTLE SYSTEMS

Thesis written with the financial contribution of Fondazione Cariparo

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CICLO XXX

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Summary

Abstract

Grazing livestock systems play a key role in the maintenance of mountain areas in Europe, contributing to human well-being through the creation of socio-ecological systems in which human activities shape ecosystems and are influenced by local and regional socioeconomic, environmental and cultural conditions. The alpine cattle husbandry is historically based on small herds of the local dual-purpose breed, usually hosted in closed barns located in the low valley, excepts for the summer period in which they are moved to high-pastures (summer farms). During last half of the 20th century, livestock husbandry in the alps had to face the impact of the processes of abandonment and intensification, which threaten the ecological functions of the mountain agroecosystems. Both trends involve land use changes, with the intensification occurring in valleys bottoms, whereas abandoned areas are mainly located at high altitudes and steep slopes. As a consequence, there are severe impacts on terrestrial, aquatic and aerial systems, a decrease in the number of farms and a progressive intensification of the remaining farms (larger herds, milk specialised breed, massive use of extra-farms feed). Issues related to livestock husbandry on food security, agroecosystem protection, biodiversity, animal welfare, social concerns and economic competitiveness, have emerged in the public and scientific debate, strongly demanding for a focus on the sustainability of the sector. Sustainability is defined as the use of available resources for meeting human development goals while maintaining the ability of natural systems to continue to provide the natural resources and ecosystem services upon which the economy and society depend. It is composed of three parts, a social, an environmental and an economic one. Approaches as multifunctionality and Ecosystem Services have been developed to value the provision of additional function apart from commodity outputs to agroecosystems. Both concepts can be used to tackle the current need and social demand for a sustainable development of mountain agroecosystems. The term of Ecosystem Services defines all the direct and indirect contributions of ecosystems to human well-being. They are categorised as provisioning, regulating, cultural and supporting services. However, if managed in an incorrect way, the ecosystem can react with what is defined as an Ecosystem Disservices (EDs), which has negative outcomes for society. The aim of this Ph.D thesis was to assess the multifunctionality of the alpine dairy cattle system in the Alpine agroecosystems, integrating the ESs framework into socio-economic approaches (choice model), and participatory approaches (questionnaire and focus group), involving and adding value to stakeholders' opinions. This Ph.D thesis is composed of three chapters. The first chapter aimed at analysing, within the Ecosystem Services framework, the sociocultural and economic value of a number of positive functions of Alpine agroecosystems, in a context

of simultaneous processes of intensification and abandonment. We first performed interviews with farmers and other local stakeholders (qualitative method) to explore the relationships between the dairy livestock systems and the environment. Then we developed a choice model to rank and value the most important functions of the current agroecosystems (dairy livestock systems and permanent crops) according to the views of local (residents of the study area) and reference (residents of the six neighbouring provinces) populations in three policy scenarios. Results showed that local stakeholders had a positive opinion of the outcomes of the mountain dairy livestock system. Regulation services, represented in the choice model by water quality, were found to be the most valuable for the well-being of society. Considering a hypothetical sustainable development scenario, people showed to be willing to compromise on production rather than cut back on environmental services. Besides, they rejected the current trend of intensification of permanent crops and dairy production with the consequent abandonment of summer pastures. It would be possible to take action to support the dairy sector and promote its sustainability since the Total Economic Value of Alpine agroecosystems calculated was €159.30 per person per year, which exceeded current expenditure on agroenvironmental programmes. The second chapter considered the farmer's ambitions regarding their life and their farm and the connection between their objectives and the real management practices on the farm located in a mountain area. We performed a principal component analyses (PCA) and a cluster analysis on data coming from face to face questionnaires, identifying three factors (quality of life through diversification, environmental goals and economic goals) and three clusters (Diversification entrepreneurs, Traditional farmers and Planner farmers). The relationships among clusters, behaviours and data on their farm structure and management were tested. The analysis highlighted differences in farmer's personal goals for their farms and trade-off between economic aspects and social sustainability that was to the detriment of the social sustainability. Significant differences among clusters were found when considering management variables related with the territory. The identification of the heterogeneity of farmers' behaviour is a relevant starting point to achieve the sustainable development of the mountain farming system and for the application of participatory approaches. The third chapter aimed at investigating the relationship between local supply chains and ESs in Austrian and Italian mountain areas, understanding also to which extent the positive added values generated are communicated to society. In order to do so, we applied a stakeholder analysis, an online survey and a focus group for both the Italian and Austrian study areas. As in the first chapter, we found a general positive vision of the effects of the livestock production chain on the mountain environment and vice versa. Only Italian stakeholders identified a negative impact on the environment, concerning water quality. Common difficulties and opinions among stakeholders of both study areas were unravelled

during the focus groups. Stakeholders expressed the need for a common network and of an increase in the collaboration among themselves, to generate a targeted communication of ESs linked to the territory maintenance of the dairy production chains in mountain areas. The results of this Ph.D thesis give interesting insights about the Ecosystem Services and sustainability evaluation of Alpine dairy cattle systems. The assessment through the use multiple tools of analysis, allowed stakeholders and researchers to improve the understanding of the relationship between human activities and the ecosystem and also to identify intervention points for problem solving.

Riassunto

I sistemi zootecnici giocano un ruolo fondamentale nel mantenimento delle aree montane Europee, contribuendo al benessere umano attraverso la creazione di sistemi socio-ecologici in cui le attività umane plasmano gli ecosistemi e sono influenzate dalle condizioni socioeconomiche, ambientali e culturali locali e regionali. Storicamente, l'allevamento zootecnico alpino si basa su piccole mandrie di razze locali a duplice attitudine. Durante la maggior parte dell'anno, le mandrie trovano riparo in stalle del fondo valle, mentre nel periodo estivo vengono trasferite nei pascoli a quote elevate, nelle malghe.

Nell'ultima metà del ventesimo secolo, l'allevamento di bestiame nelle alpi ha dovuto affrontare l'impatto dei processi di abbandono e di intensificazione, i quali minacciano le funzioni ecologiche degli agroecosistemi montani. Entrambe le tendenze implicano dei cambiamenti nell'uso del suolo, con l'intensificazione che prende piede nel fondo valle, mentre le aree abbandonate si localizzano principalmente alle altitudini più elevate e lungo i pendii più ripidi. Di conseguenza, si verificano impatti severi sui sistemi acquatici, aerei, e terrestri; una diminuzione nel numero delle aziende zootecniche e una progressiva spinta all'intensificazione delle aziende rimanenti (mandrie più grandi, razze specializzate da latte, uso massiccio dei mangimi extra-aziendali). I problemi legati all'allevamento zootecnico sulla sicurezza alimentare, sulla protezione degli agroecosistemi, sulla biodiversità, sul benessere animale, sulle preoccupazioni sociali e culla competitività economica, sono emersi nel dibattito pubblico e scientifico, richiedendo a gran voce una maggiore attenzione sulla sostenibilità del settore. La sostenibilità viene definita come l'uso delle risorse disponibili per raggiungere gli obiettivi dello sviluppo umano mentre si mantiene la capacità dei sistemi naturali di continuare a fornire le stesse risorse naturali e i Servizi Ecosistemici su cui dipendono l'economia e la società. La sostenibilità si compone di tre parti: una sociale, una ambientale e una economica. Per valutare l'approvvigionamento delle funzioni dell'ecosistema, che non rientrino nell'ambito della fornitura di beni di mercato, sono stati sviluppati degli approcci come la multifunzionalità e i Servizi Ecosistemici. Entrambi i concetti posso essere usati per affrontare il bisogno corrente e la domanda sociale di uno sviluppo sostenibile degli agroecosistemi montani. Il termine Servizi Ecosistemici definisce tutti i contributi diretti e indiretti di un ecosistema al benessere umano. Sono categorizzati come servizi di approvvigionamento, di regolazione, culturali e di supporto alla vita. In ogni caso gli ecosistemi, se gestiti in maniera erronea, possono regire con quelli che vengono definiti Disservizi Ecosistemici, che hanno impatti negativi per la società.

Lo scopo della mia tesi di dottorato è stato quello di stimare la multifunzionalità dei sistemi di allevamento di vacche da latte negli agroecosistemi alpini, integrando la struttura teorica dei Servizi Ecosistemici negli approcci socio-economici (modelli di scelta), negli approcci partecipativi (questionari e gruppi di discussione), coinvolgendo e valorizzando l'opinione dei portatori di interesse. Questa tesi di dottorato è composta da tre capitoli.

Il primo capitolo della tesi, puntava all'analisi, nell'ambito della teoria dei Servizi Ecosistemici, del valore socioculturale ed economico di un numero di funzioni positive degli agroecosistemi alpini, in un contesto di due processi simultanei di intensificazione e di abbandono. Per prima cosa, furono svolte delle interviste con gli allevatori e con altri portatori di interesse locali (metodo qualitativo), per esplorare la relazione tra i sistemi zootecnici da latte e l'ambiente. In seguito, fu sviluppato un modello di scelta per classificare e valutare le più importanti funzioni attuali degli agroecosistemi (i sistemi zootecnici da latte e le colture permanenti), secondo i punti di vista delle popolazioni locali (residenti nell'area di studio) e di riferimento (i residenti delle sei provincie confinanti l'area di studio) in tre diversi scenari politici. I risultati hanno mostrato che i portatori di interesse locali avevano una opinione positiva delle attività del sistema zootecnico da latte di montagna. I servizi di regolazione, rappresentati nel modello di scelta dalla qualità dell'acqua, sono stati considerati come i più importanti per il benessere della società. Considerando uno scenario ipotetico di sviluppo sostenibile, le persone si sono mostrate propense al compromesso sulla produzione lattiero-casearia piuttosto che sulla riduzione dei Servizi Ecosistemici. Inoltre, hanno rifiutato il processo corrente di intensificazione delle colture permanenti e della produzione lattiero-casearia, con il conseguente abbandono dei pascoli alpini. Dato che il valore economico totale degli agroecosistemi alpini calcolato è risultato essere di €159.30 pro capite all'anno, che eccede la spesa corrente sui programmi agroambientali, sarebbe possibile intraprendere azione per supportare il settore zootecnico da latte e promuovere la sua sostenibilità.

Il secondo capitolo ha preso in considerazione le ambizioni degli allevatori riguardo la loro vita e la loro azienda, e la connessione tra i loro obiettivi e le reali pratiche di gestione applicate nelle loro aziende montane. Un'analisi in componenti principali (PCA) e un'analisi dei gruppi è stata portata a termine partendo da dati raccolti tramite interviste personali, identificando tre fattori (qualità della vita ottenuta tramite la diversificazione aziendale; obiettivi ambientali; obiettivi economici) e tre gruppi (imprenditori della diversificazione, allevatori tradizionali, allevatori pianificatori). Furono inoltre testate le relazioni tra i gruppi, i comportamenti e i dati sulla struttura e sulla gestione aziendale. Le analisi hanno messo in luce delle differenze negli obiettivi personali degli allevatori per quanto riguardava le loro aziende, e un equilibrio tra gli aspetti economici e la sostenibilità sociale che pendeva a

sfavore di quest'ultima. Prendendo in considerazione le variabili di gestione territoriale, sono state trovate differenze significative tra i gruppi . L'identificazione dell'eterogeneità del comportamento degli allevatori è un punto di partenza fondamentale per raggiungere uno sviluppo sostenibile nei sistemi zootecnici montani e per l'applicazione di eventuali approcci partecipativi. Il terzo capitolo della tesi mirava ad investigare la relazione tra le strutture di approvvigionamento locale e i Servizi Ecosistemici nelle aree montane italiane e austriache, cercando anche di capire a che livello viene comunicato alla società il valore aggiunto generato dalla filiera. Per fare ciò, sono state messe in atto un'analisi dei portatori di interesse, una indagine online e un gruppi di discussione sia per l'area di studio italiana che per quella austriaca. Come nel primo capitolo, in generale è stata trovata una visione positiva degli effetti della filiera zootecnica da latte sull'ambiente montano e vice versa. Solo i portatori di interesse italiani hanno identificato degli impatti negativi sull'ambiente, che riguardavano principalmente la qualità dell'acqua. Durante i gruppi di discussione, è stata fatta luce sulle comuni difficoltà e opinioni tra i portatori di interesse di entrambe le aree di studio. I portatori di interesse hanno inoltre espresso il bisogno di una rete di comunicazione comune e di un incremento nelle collaborazioni tra di loro, con l'obiettivo di mirare la comunicazione sui Servizi Ecosistemici legati al mantenimento del territorio e alla produzione zootecnica da latte nelle aree montane. I risultati di questa tesi di dottorato offrono spunti interessanti sui Servizi Ecosistemici e sulla valutazione della sostenibilità del sistema zootecnico di vacche da latte nelle alpi. La stima attraverso l'uso di numerose metodologie di analisi, ha permesso ai portatori di interesse e ai ricercatori di migliorare la comprensione delle relazioni tra le attività umane e gli ecosistemi, identificando possibili punti di intervento per la futura risoluzione dei problemi.

General introduction

Mountain agroecosystem's importance and threats

Europe's ecological backbone is formed by mountains, which contribute to human well-being in many different ways (EEA, 2010; Grêt-Regamey et al., 2012). As an example, mountains agroecosystems can provide food and raw materials (crops, fodder, water, fuels, wood) (Briner et al., 2013b; Cooper et al., 2009), protection and support for human health (prevention of soil erosion, climate regulation, medical plants) (Bernstein, 2014; Ruiz-Mirazo et al., 2011) or recreational and cultural experiences (Schirpke et al., 2016). Therefore, mountain areas own a social, economic and environmental importance which is recognized through national legislation since the late 19th century (EEA, 2010). Besides, at the European level, 69 % of the mountain areas have been designated as Least Favoured Areas (LFAs) and a further 23 % is defined as High Natural Value (HNV) farmland. As a fact, 95 % of HNV farmland overlaps LFA designation (EEA, 2010). HNV has been described by Beaufoy and Cooper (2009) as the farming systems and the farmland that, thanks to particular characteristics, can be expected to support high levels of biodiversity, species, and habitats of European conservation concern. Therefore, HNV farming is formed by the physical farmland and by the agricultural practices and farming systems necessary for its maintenance (Strohbach et al., 2015). Livestock and crop systems are both suitable for this type of farming (Baldock et al., 1994), creating socio-ecological systems in which human activities at the same time shape ecosystems and are influenced by local and regional socioeconomic, environmental and cultural conditions (Kareiva and Marvier, 2012). HNV farming is often based upon traditional farming practices (Bignal and McCracken, 2000) which are often the low input systems considered fundamental for HNV farming conservation (Baldock et al., 1994; EEA, 2010).

Agricultural and farming activities in mountain areas have to face a variety of unfavourable natural situations which complicate the production process and reduce the agricultural productivity, such as limitation from physical factors (poor soils, steep slopes, high altitude), a shorter growing season and extreme weather conditions, poor transport and infrastructure conditions (Floor Brower, 2004). With this in mind, for HNV farming located in mountain territories challenges are also increased by two ongoing processes of intensification and abandonment, which threaten the ecological functions of the mountain agroecosystems (EEA, 2010; Stoate et al., 2009; Strohbach et al., 2015).

Both processes go on from the last half of the 20th century. Intensification of crop and animal production was initiated by the Green Revolution (Bouwman et al., 2006) and then livened up by a quick increase in the opportunity labour and costs and by the European Common Agricultural Policy (CAP) (Strijker, 2005). Contemporary, socioeconomic factors such as the transfer of rural people into areas offering better economic opportunities(Rey Benayas, 2007), generated an abandonment process of mountain areas (MacDonald et al., 2000). Both trends involve land use changes and can occur in parallel sometimes in the same area (Battaglini et al., 2014). In mountain areas, the intensification occurs in valleys bottoms, more favourable mechanisation (Cocca et al., 2012) where meadows are used in a very intensively (several cuts per season) or transformed into annual or permanent cropland (Schirpke et al., 2017). Farm size and external input consumption (extra farm concentrates and fertilizers) are increased (Battaglini et al., 2014; Stoate et al., 2009), while structural elements such as hedgerows and buffer zones are eliminated (Diacon-Bolli et al., 2012). As a consequence, there are severe impacts on terrestrial, aquatic and aerial systems (Stoate et al., 2009), such as less plant and animal biodiversity (Marini et al., 2008a, 2008b) and a greater risk of soil erosion (Newesely et al., 2000) and water pollution (Dale and Polasky, 2007; Gordon et al., 2010). Abandoned areas are mainly located at high altitudes and steep slopes, when the management costs are high (Rutherford et al., 2008). Due to a former forest clearing, they are mainly located below the actual treeline (Pecher et al., 2011) and therefore subject to natural reforestation (Tasser et al., 2007a). The impacts are changes in landscape patterns (Tasser et al., 2007a) with loss of identity and landscape attractiveness (Tengberg et al., 2012), a reduced forage provision (Briner et al., 2013a) and increased hazards risks (Navarro and Pereira, 2015; Newesely et al., 2000; Stoate et al., 2009). Besides, both processes of intensification and abandonment have caused a decline in biodiversity (Lambin et al., 2000; Zimmermann et al., 2010). Even so, some positive effects coming from the abandonment have been discovered regarding carbon sequestration (Levers et al., 2015; Nagler et al., 2015), erosion control (Egarter Vigl et al., 2016), water regulation, timber production and recreational activities (Navarro and Pereira, 2015). All the previous impacts occur at different time scales (Hein et al., 2016), which could be several centuries, as in the case of timber production after a complete forest regrowth (Tasser et al., 2017), or just a matter of years, as the effect of shrub encroachment on aesthetic values (Schirpke et al., 2013).

Concerns for all these functions, affected by intensification and abandonment, led to the creation of the “multifunctional approach”, which recognizes the provision of additional function apart from commodity outputs to agroecosystems (Bernués et al., 2015; OECD, 2001). Examples of the outputs or positive externalities are water quality, animal welfare and

biodiversity, maintenance of landscapes and cultural values, soil functionality and food security. Cooper et al. (2009) stated that the majority of these functions have characteristics of public goods (non-market goods). Thus, they are contemporary non-excludable and non-rival, or in other words, an individual cannot be excluded from the benefit and its use of the good does not decrease the availability for the others individuals. Another conceptual framework, the “Ecosystem Services” approach, has recently become prominent in the literature (Rodríguez-Ortega et al., 2014), aiming at valorising nature's services in decision systems to correct misperceptions regarding the relationship between humans and nature (TEEB, 2010). The two concepts are related, since they both recognize the need to evaluate the multidimensional socioecological systems in order to increase the human benefit, taking into consideration the perceptions and needs of different stakeholders (Bernués et al., 2015). They also have some differences, as for example the main level of analysis (the farm or the agricultural region for multifunctional agriculture) or for the focus (ES is a service-centred approach) (Bernués, 2016; Renting et al., 2009). Both concepts can be used to tackle the current need and social demand for a sustainable development of mountain agroecosystems.

Mountain livestock traditional systems

Grazing livestock systems play a key role in the maintenance of mountain areas in Europe (MacDonald et al., 2000). Livestock husbandry presents a high level of heterogeneity across the European mountains (Battaglini et al., 2014), strongly subjected to climatic limitation for feedstuff production because traditionally based on forages and pastures (Andrighetto et al., 1996). These resources, which are not usable for human nutrition, have been used for centuries by cattle and small ruminants raised in extensive or semi-extensive systems (Battaglini et al., 2014). Among the diverse livestock production systems, we focused on the dairy cattle system In the Alps. The alpine cattle husbandry is historically based on small herds of local dual-purpose breeds (well adapted to the mountainous environment and once widespread in the Alps) for milk and calves or meat production. The animals are usually hosted in closed barns located in the low valley, excepts for the summer period in which they are moved to high-pastures (summer farms) (Battaglini et al., 2014). The regular practice of transhumance of livestock to summer pastures allows the optimal exploitation of natural resources matching the grazing pressure to seasonal peaks in pasture productivity (Ruiz and Ruiz, 1986). In fact, the traditional dairy systems in the Alps has always been defined by a positive link between the livestock husbandry and territory management, to provide food

(milk and meat) and also positive externalities and ESs, such as water flow and climate regulation, pollination, conservation of genetic resources, landscape and cultural heritage maintenance (EEA, 2010; MEA, 2005; Rainis et al., 2013).

Besides the unfavourable natural situations that we listed in the previous paragraph on the inherent difficulties of a farming production process in the mountain, livestock husbandry in the alps had to face the impact of the processes of abandonment and intensification. In some areas, the recent economic crisis and the market globalisation have been affecting for a while the agricultural activities, hitting more strongly small farms, which are the most diffuse kind of mountain farm (ISTAT, 2010; Mazzocchi and Sali, 2016). Between the period of 1980 and 2000, the number of farms decreased by 40%, whereas livestock units dropped by 17 %. The remaining farms tended to increase the number of animals, creating a scenario of fewer farms with larger herds than in the past. Farms are becoming progressively more similar to the intensive farms of the plains, with productive breeds specialised in milk production and with the massive use of extra-farms feed (Streifeneder et al., 2007). The highest percentage of closures occurred in the most decentralised areas of the alps (Giupponi et al., 2006; Tasser et al., 2007b). In some areas, transhumance is gradually disappearing due to the labour costs and the low profitability (Mazzocchi and Sali, 2016). The possibility of innovation and investment are impaired by the ageing of the population, lack of new younger farmer and adequate infrastructures and of high transport costs (Dax, 2004; MacDonald et al., 2000). The role of livestock husbandry in the mountainous territory has been assessed as strategic to enhance the development of rural communities and enhance environmental conservation (Bernués et al., 2015).

Concerns regarding livestock farming systems and sustainability

Issues strongly related to livestock husbandry on food security, agroecosystem protection, biodiversity, animal welfare, social concerns and economic competitiveness, forced the public and scientific debate to focus on the social demand for sustainability (Gamborg and Sandøe, 2005; Lebacq et al., 2013; ten Napel et al., 2011). Sustainability was defined as the use of available resources for meeting human development goals while maintaining the ability of natural systems to continue to provide the natural resources and ecosystem services upon which the economy and society depend (Brown et al., 1987; Brundtland et al., 1987; Kahle and Gurel-Atay, 2015). Therefore the real sustainability is achieved when the social, environmental and economic sustainabilities are contemporary satisfied. As Thompson (1992) wittily wrote, if we would only focus on specific production and resources

criteria, it would be possible to describe sustainable systems that few would find worth praising or continuing, as for example slave agricultures of Egypt.

In order to assess the achievement of these goals, there have been in the past an “indicator explosion” which created a real risk of confusion for potential users (Bockstaller et al., 2009; Riley, 2001). Bockstaller et al. (2008) analysed that indicators available can be a result of a measurement, or of a simple calculation based on a combination of data, or of the result of a simulation derived from a complex model. Besides, all the approaches proposed presented some kind of challenges, as for example the selection of the suitable method or set of indicators (Lebacq et al., 2013; Meul et al., 2007). What is more, most of the studies focus on the environmental impact, forgetting the economic and social components (Darnhofer et al., 2010).

Indicators used to assess environmental sustainability are usually based on the impacts of agricultural practices and of external factors (van der Werf et al., 2009). Indicators based on technical resources and inputs of the farm (e.g. livestock stocking rate) are easy to measure, sensitive to production practices, but with a low quality of environmental impact prediction (van der Werf et al., 2009; Van Der Werf and Petit, 2002). Those addressing the state of the system (e.g. amount of post-harvest soil nitrate) and those concerning farm’s polluting emissions and their potential impact (e.g. LCA approach) have as main limitation their complexity (Bockstaller et al., 2008; Halberg et al., 2005). Finally there are indicators directly measured that reflect the impact of the practices (e.g. actual groundwater nitrate concentration), which covers usually a large spatial scale and have a high environmental relevance, but they are also more costly, time-consuming, complex and difficult to measure from a practical point of view (Bockstaller et al., 2008; van der Werf et al., 2009; Van Der Werf and Petit, 2002).

A farming system is defined economically sustainable if it is able to generate profit for the wellbeing of the farming community (van Calker et al., 2007; Van Cauwenbergh et al., 2007). The most commonly used economic indicators refer farm income, efficiency, and productivity (Lebacq et al., 2013). However, researchers look out also for the autonomy of the farm (e.g. use of external inputs), for the diversification of the income (e.g. agritourism) and for farm’s succession and transmission over time (Guillaumin et al., 2007).

Social sustainability can be defined at farm community level (education, working conditions, and quality of life of the farmer and his family), or at society level (multifunctionality, acceptable agricultural practices, and quality of products) (Guillaumin et al., 2007; van Calker et al., 2007; Van Cauwenbergh et al., 2007).They both depend on values and concerns, which are subjected to changes. Therefore, little is available on social

sustainability quantification (van Calker et al., 2007), whereas qualitative approaches imply the self-evaluation by the farmer (Vilain, 2008). It is possible to borrow from psychologist different theoretical approaches which can be used to explain how farmer's goals, objectives and attitudes are determinant factors to understand the farmer's behaviour.

The "Theory of Reasoned Action" (Ajzen and Fishbein, 1975) developed then in the "Theory of Planned Behaviour" by Ajzen, (1991), use beliefs (behavioural, normative, and control) linked with attitude, subjective norm and perceived behavioural control to explain the readiness of an individual to perform a given behaviour. In another theory, the "Transactional Model of Behaviour" (Lazarus and Folkman, 1987), person factors (e.g. personality) and external/physical farm factors (e.g. the environment) contributes together to the shaping of different aspects of farmers' behaviour concerning their business. Hereafter, as reviewed by Edwards-Jones, (2006), studies have used these theories as the base upon which construct a model which could include the adoption of environmental activities (Beedell and Rehman, 2000), environmental and business oriented behaviour (Willock et al., 1999), technology adoption (Lynne et al., 1995) and the planting of trees (Zubair and Garforth, 2006).

Anyway, all the indicators listed above, especially those for the environment, accounts only for negative impacts of a farming system, not quantifying the positive externalities or the Ecosystem Services provided by a well-balanced farming system. In general, the focus is on the negative sides, which are indeed relevant in a global context of growing demand and production of animal products in the near future (Wilkinson, 2011). In fact, the aspect of the animal husbandry that has received a special attention is the emission of greenhouse gas (GHG), which is related to climate change (Rojas-Downing et al., 2017; Steinfeld et al., 2006) quantified it as 14.5% of global GHG emissions. GHG emissions are calculated for a litre of milk or kg of meat produced, and their quantity highly depends on the type production system (Berton et al., 2016).If the model does not take into account the multifunctionality or the model do not expand the analysis including for example land use issues, the carbon footprint will be lower for intensive production (Ripoll-Bosch et al., 2013).

Besides, low-input grazing farming systems do not compete with human nutrition, since they graze grass, and they need less energy (especially for oils) respect the intensive systems (OECD, 2008; Wilkinson, 2011). As we described in the previous chapters, grazing livestock systems are fundamental for the maintenance of mountain areas and the conservation of HNV farmland, thanks to their delivery of multifunctional outputs and ESs. The important point to highlight is that the environmental impact of animal husbandry (positive or negative) depends on the degree of intensity of the system and on how it integrates into the territory (Gliessman and Engles, 2007).

ES framework and valuation approaches

Mountain ecosystems provide goods and services to local people and to those leaving in other areas (MEA, 2005; TEEB, 2010). In fact, as an example, freshwater from mountain regions is a fundamental resource from half of humankind. The first that suggested that social value of the benefits coming from an ecosystem could be potentially counted to allow society to take more informed policy and management decisions was Westman (1997) (Grêt-Regamey et al., 2012). The concept was defined "Ecosystem Services" by Ehrlich and Ehrlich (1981) and popularized by the Millennium Ecosystem Assessment (MEA, 2005) as the all the direct and indirect contributions of ecosystems to human well-being. According to the MEA, the ESs framework is formed by four groups (Rodríguez-Ortega et al., 2014): i) *provisioning services*, such as food, water, timber, or fibres; ii) *regulating services*, biophysical processes related to climate, air quality, water flow, natural hazards, diseases, wastes; iii) *cultural services*, are associated with tourism, recreation, aesthetics, protected areas and spiritual benefits; iv) *supporting services*, which are on the basis of the generation of the other ESs, such as nutrient cycling, photosynthesis and soil formation. The term ESs focus the attention on human well-being and is intended to have a positive sense (D'Ottavio et al., 2017). However, if managed in an incorrect way, the ecosystem can react with what is defined as an Ecosystem Disservices (EDs), which has negative outcomes for society (Zhang et al., 2007). For example, use of pesticides in the past decades has brought some pest species to develop resistance, worsening the problem and increasing the use of chemicals, with unintended negative health outcomes for hon-target organisms, humans included (Thomas, 1999).

As shown above, the classification is rather complex and many approaches have been proposed during the years. The three most known and recognized frameworks are the "Millennium Ecosystem Assessment" (MEA), "The Economics of Ecosystems and Biodiversity" (TEEB), and the "Common International Classification of Ecosystem Services" (CICES)(Haines-Young and Potschin, 2013). The TEEB presents an approach that highlights the values of biodiversity and Ecosystem Services, the growing costs of biodiversity loss and ecosystem degradation, and the benefits of action addressing these pressures. The classification consists of four groups as for the MEA, except that the *supporting* ESs are grouped with the *regulating* ESs, and in that, we found extra categories named *habitat or supporting services*. The CICES, under development, focuses on the ESs dimension and is trying to be more comprehensive than the previous ones (Haines-Young and Potschin, 2013).

Publications on ESs have grown exponentially during the past two decades (Fisher et al., 2009). In the review of Rodríguez-Ortega et al. (2014), that explored the application of ES framework to European pasture-based livestock farming systems, we can see that the coverage in literature of non-provisioning ESs (regulating, cultural and supportive services) was extremely irregular, whit the majority of the publication focusing on only three ESs: gene-pool protection, including biodiversity, 30.5 %; aesthetic value of landscape 27.3%; and climate regulation 12%. Thanks to their integrative characteristics, the ESs framework has an elevated potential for application in environmental and resource management, (de Groot et al., 2010). Other important aspects of the concept are the consideration of the supply and demand of the ESs (Burkhard et al., 2013; Grêt-Regamey et al., 2012), as well as the consideration of multiple trade-offs (when the increase of the use of an ES is reduced by the major use of another ES) and synergies (when multiple ES are enhanced simultaneously) (Rodríguez-Ortega et al., 2014). The use of the ESs framework for the evaluation of the sustainability of like livestock farming systems is increasing.

Different approaches have been developed (biophysical, socio-cultural and economic) in order to quantify the value of the multidimensionality of ecosystems within the ESs framework (Martín-López et al., 2014a).Considering a variety of different land-use management it is possible to infer an economic valuation of gain, losses and trade-offs from a monetary point of view (Hicks et al., 2009; Martín-López et al., 2011). Sometimes is appropriate to base the approach on market costs, when mitigating or replacing costs for the services are available. Otherwise, if the ESs considered do not have a market reference, there are techniques of indirect assessment (e.g.travel cost, contingent valuation, etc.) (de Groot et al., 2010; Rodríguez-Ortega et al., 2014; Swinton et al., 2007). The biophysical valuation considers directly the structural and functional aspects of ecosystems. This orientation applied to animal husbandry, measuring how the different management practices affect in a positive or negative way the ESs, allows to objectively value the delivery of ESs at different scale according to different land management (Costanza et al., 1997; Viglizzo et al., 2011). Socio-cultural assessments focus on the preferences, needs, values, norms, and behaviours of different stakeholders (individuals, institutions, organizations, etc.) towards ES (Cowling et al., 2008).This approach force to reflect on who are the beneficiaries of ESs provision (Orenstein and Groner, 2014), unravelling people's diverging values concerning the ESs (Chee, 2004; Kumar and Kumar, 2008), improving the understanding of the relationship between humans and nature (Chan et al., 2012) and discovering possible intervention points for problem solving among stakeholders (Martín-López et al., 2014b, 2012). Nevertheless, most ESs assessments focus on the biophysical or on economic valuation (Nieto-Romero et al., 2014; Plieninger et al., 2013; Seppelt et al., 2011), and only a

few take into consideration only the socio-cultural preferences of stakeholders using a non-economic approach (Martín-López et al., 2012; Menzel et al., 2010). Socio-cultural values are fundamental in a situation in which one needs to deal contemporary with opposite trends in the same geographical area (Grêt-Regamey et al., 2012).

In the EU there is a recognized need to use the ES approach to introduce policy changes and to integrate agricultural policies with other sector policies (e.g. biodiversity) (European Commission, 2011). Therefore, to design an intervention plan or policy, information and tools to evaluate the ESs are of major importance. What is more, to have socially acceptable, and thus effective, policies, the approach should be "bottom-up", i.e. it should involve stakeholders of the system (Bernués et al., 2016), which is considered essential to the success of any conservation policy (Fischer and Young, 2007). The integration of stakeholders in the policy process would enhance the trust on the framework and would help to tackle the vulnerabilities of the livestock system as a central issue (Huber et al., 2013). Innovative approaches to improve business competitiveness and an economic revitalization of the mountain livestock sector should go at the same pace than conservation goals for ESs. A way to sustain the ESs provision are the payments for ecosystem services (PES) (Engel et al., 2008). The absence of subsidies for grassland farming would involve a decline in provisioning services and a worsening of both trends of abandonment and intensification, especially at high altitudes (Briner et al., 2013a).

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Objectives

The objectives of this thesis were:

1) To assess the sociocultural and economic values of ESs provided by Alpine agroecosystems, identifying local stakeholders perception of ESs and EDs delivered by traditional dairy farming and measuring the willingness to pay that the local population and the general population assign to key ESs in a mountain area.

2) To analyse farmer's goals and behaviours regarding their livestock farm in a mountain contest, different farming styles and assessing the connection with the actual farm management practices.

3) To study in deep the relation between the mountain livestock production chain, the mountain ESs and the local stakeholder's perception of the impact of the dairy livestock system.

Chapter 1

Socio-economic valuation of abandonment and intensification of Alpine agroecosystems and associated ecosystem services

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Abstract

The aim of the study was to analyse, using the ecosystem services framework, the sociocultural and economic value of a number of positive functions of Alpine agroecosystems (in north-eastern Italy) in a context of simultaneous processes of intensification and abandonment. Firstly, we used qualitative methods (interviews with farmers and other local stakeholders) to explore the relationships between the dairy livestock systems and the environment. Secondly, we used a choice model to rank and value the most important functions of the current agroecosystems (dairy livestock systems and permanent crops) according to the views of local (residents of the study area) and reference (residents of the six neighbouring provinces) populations in three policy scenarios. We found that all the local stakeholders had a positive opinion of the outcomes of the mountain dairy livestock system. Within the current agroecosystems, regulation services (water quality) were found to be the

most valuable for the well-being of society. Moreover, people were willing to compromise on production (quality products) rather than cut back on environmental services in a hypothetical sustainable development scenario. The current trend of intensification of permanent crops and dairy production with the consequent abandonment of summer pastures was rejected by respondents. The Total Economic Value of Alpine agroecosystems was €159.30 per person per year, which clearly exceeded current expenditure on agroenvironmental programmes.

Keywords: dairy cattle, landscape, biodiversity, water quality, high quality products, policy scenarios

Introduction

Long-term, human-made agroecosystems are defined as “cultural landscapes” (Martín-López et al., 2012) and are important providers of ecosystems services (ES) (Swinton et al., 2007; Zhang et al., 2007). In mountain areas, extensive livestock systems have contributed to the creation and maintenance of semi-natural habitats (Rodríguez-Ortega et al., 2014). The main differences between these and other agricultural systems lie in the use of traditional, low-input practices and in land management, notably as meadows and pastures, especially in less favourable and less accessible areas. Mountain agroecosystems can provide food and raw materials (crops, fodder, water, fuels, wood) (Briner et al., 2013b; Cooper et al., 2009), protection and support for human health (prevention of soil erosion, climate regulation, medical plants) (Bernstein, 2014; Ruiz-Mirazo et al., 2011) or recreational and cultural experiences (Schirpke et al., 2016). Additionally, mountain ecosystems are very sensitive to subtle environmental shifts, which can have serious consequences on land use (Houet et al., 2010)

Despite that, over the past 200 years, societal, technological and economic inputs have contributed heavily to reshape the landscape (Jepsen et al., 2015). The press of agricultural intensification on valley bottoms or on terraces (Bürgi et al., 2015a), the process of land abandonment in less-favoured areas (Tasser et al., 2007), the economic pressure from international management direction (Jepsen et al., 2015), the urban extension (Antrop, 2004) and the shift in tourism activities (Geneletti, 2008) are all potential causes of the changes. Besides that, during the last half of the 20th century, there was also a decline in traditional extensive livestock systems, which had various consequences on the local scale (MacDonald et al., 2000). In general, there was an abandonment of mountain pastures and

the steepest mountain areas, whereas intensification took place in the valleys, which are more disposed to mechanisation (Cocca et al., 2012; Strijker, 2005). Between 1990 and 2010, 17% of meadows and pastures in the eastern Italian Alps were abandoned (Ramanzin et al., 2014). Trends in both types of land use change - abandonment and intensification - occur in parallel, often in the same area (Monteiro et al., 2011).

The consequences of the concurrent processes of intensification and abandonment are manifold, and although they are likely to vary according to the particular agroecosystem, the local socioeconomic context and the temporal scale, general patterns can be identified. On the one hand, the general process of intensification of traditional farms (Cocca et al., 2012) has involved management changes, such as: (a) intensive management of meadows with increased use of fertilizers and greater cutting frequency (Marini et al., 2009); (b) increased importation of external inputs (off-farm concentrates and agrochemicals) (Battaglini et al., 2014); and (c) conversion of meadows into arable land and elimination of structural elements (hedgerows, buffer zones, etc.) to facilitate mechanisation processes (Diacon-Bolli et al., 2012). As a consequence, there is less plant and animal biodiversity (Marini et al., 2008a, 2008b) and a greater risk of soil erosion (Newesely et al., 2000) and water pollution (Dale and Polasky, 2007; Gordon et al., 2010). On the other hand, abandonment of farming may result in: (a) gradual encroachment of shrubs and trees on meadows and pastures, especially on the valley slopes (MacDonald et al., 2000; Tasser et al., 2007); (b) loss of grassland biodiversity (Benton et al., 2003); (c) increased risks of erosion and hazards, such as wildfires and avalanches (Newesely et al., 2000; Stoate et al., 2009); and (d) landscape homogenisation and loss of cultural landscapes and traditional management techniques and knowledge (Lasanta et al., 2015). Impacts occur at different time scales (Hein et al., 2016), which could be several centuries, as in the case of timber production after a complete forest regrowth (Tasser et al., 2017), or just a matter of years, as the effect of shrub encroachment on aesthetic values (Schirpke et al., 2013). Anyway, a modification of the landscape implies a different provision of related ESs (Fu et al., 2015).

In fact, agricultural systems can deliver multiple ESs and ecosystem disservices (EDS) depending on the intensity of the production system and the use made of resources (Bernués et al., 2011; Steinfeld et al., 2006). Where production is the primary goal, economic pressures and vital issues of food safety mean that farmers have little incentive to operate management systems that provide outputs which may often be non-market goods. One way to address the problem could be by so-called ‘green payments’ (payments to farmers who voluntarily adopt sustainable or environmentally-benign farming practices; Tilman et al., 2002). These payments can be effective in maximizing social welfare, assuming that the multiple functions of agriculture are correctly valued. However, errors may arise from the

difficulty of assigning a value to non-market goods and services that are very different from one another and that are dependent on the socioeconomic context and society's perceptions (Randall, 2002). In order to properly address this issue, further information on the production context, social demands and ecological functions is required. Given the many competing demands for land, we should ask how we can arrive at the right balance between food provisioning and other ESs, and between land use intensification and abandonment, taking into account society's opinions of these issues.

Recently, there has been an effort in the literature to analyse multiple ESs (mostly in quantitative terms) in different Alpine regions, where also simultaneous intensification and abandonment processes occurred. Often the studies focus on landscape and land use, mapping and modelling changes of specific or a combination of ESs either on a single case study (Bürgi et al., 2015b; Schirpke et al., 2013) or on a single point in time (Crouzat et al., 2015; Grêt-Regamey et al., 2014; Lamarque et al., 2011). An interesting approach was applied by Egarter Vigl et al. (2017, 2016), combining transnational and temporal components and then performing with a spatial approach the analysis the history of ESs developments and interrelationships. Briner et al. (2011) verified that environmental shifts and economic decisions influence land-use. Some studies integrated into the analysis the stakeholder's preference of ESs (mainly cultural) (Schirpke et al., 2016; Schmidt et al., 2017; Soliva et al., 2010; Zoderer et al., 2016). Socio-economic scenarios and the participation of stakeholders were applied together in the study of Schirpke et al., (2017). This study quantified the future impact of land-use and climate changes on multiple ecosystem services in mountain grassland, including on their resilience potential. Also, Martínez-Sastre et al., (2017) applied future scenarios under different drivers of land use change to analyse how such changes would affect people living or making use of ESs. Though, to the best of our knowledge, none of the previous studies in the Alpine context applied socio-economic scenarios to let stakeholder's assign a monetary value to all the categories of ESs, in order to give a useful and practical reference for the stakeholder's perception and to improve the decision making processes.

The aim of this study was to assess the sociocultural and economic values of a number of ecosystem services provided by Alpine agroecosystems in a context of simultaneous intensification in favourable areas and abandonment of mountain pastures. Firstly, we identified local farmers' and nonfarmers' sociocultural perceptions of the ecosystem services and disservices delivered by traditional dairy farming. Secondly, we ranked and measured the economic value of the most important ecosystem services delivered by agroecosystems (including dairy and permanent crops) under different policy scenarios (current situation, further intensification-abandonment and sustainable development).

Materials and methods

To address the objectives above, the study was carried out in two steps. Firstly, at the local level, we analysed the sociocultural perceptions of local stakeholders - farmers and nonfarmers - regarding the ESs and EDSs linked to mountain dairy farming in the area (section 2.2). Secondly, at the general level, we analysed society's willingness to pay for ESs delivered by the current agroecosystems (including dairy and permanent crops) across various policy scenarios defined in biophysical terms (section 2.3).

Study area

The study area is the Autonomous Province of Trento (north-eastern Italian Alps), which covers an area of 6,200 km^2 and which is mainly mountainous (elevation ranging from 66 to 3,769 m a.s.l.), containing many glacial lakes and traversed by many streams and rivers. Almost 83% of the 1,372 km^2 of the Utilized Agricultural Area (UAA) consists of meadows and pastures (ISTAT, 2010). Meadows for hay production are located mainly in the valleys, whereas pastures for summer livestock grazing are usually located above 1,600 m a.s.l.

The study area is mainly devoted to dairy livestock, with dairy farms accounting for 76% of the province's 1,403 cattle farms (ISTAT, 2010). Almost 90% of the milk produced is processed by local dairy cooperatives (Merz, 2011) to manufacture a wide variety of Protected Designation of Origin (PDO) cheeses (mainly "Trentingrana"; Bittante et al., 2011). Almost all the farms move replacement cattle to highland pastures during the summer, whereas only a third of them move lactating cows (Sturaro et al., 2013). Summer farms are publicly owned and each of them normally accommodates animals from more than one permanent farm. According to Zendri et al. (2013), there were 395 summer farms active in 2010, many of which are also equipped to produce cheese on site.

However, dairy farming has undergone simultaneous processes of abandonment, the number of farms having declined by almost 80% between 1980 and 2010 (ISTAT, 2010), and intensification, the average herd size having increased from 5 to 23 dairy cows (Sturaro et al., 2013). During the same period, there was a 7% reduction in meadows and pastures and a 5% reduction in UAAs, mostly as a result of natural re-afforestation following the abandonment of farming (ISTAT, 2010). On the other hand, there has been an expansion of intensive permanent crops (mainly vineyards and fruit trees). Vineyards, for example, have

increased by 15%, spreading up from the bottom to the sides of the valleys (ISTAT, 2010). These permanent crops compete with meadows and forage crops on the mountain sides, and intensive agriculture is reported to be the main pressure on water quality in the study area, which is declining locally at various sites (APPA, 2017). The ongoing processes of expansion and intensification at the expense of grasslands and cultivated meadows in the study area has negative effects on landscape heterogeneity and biodiversity (Assandri et al., 2016; Nascimbene et al., 2013; Zimmermann et al., 2010). Vineyards, for example, have been associated with a high risk of soil loss (Galati et al., 2015) and frequent pesticide treatments to maintain high levels of productivity (Vischetti et al., 2008).

Sociocultural valuation of ESs and EDSs provided by mountain dairy farming

During the summer of 2016, we carried out a survey to gather the opinions of the population living in the study area regarding the relationships, both positive and negative, between the dairy livestock system and the environment. The results of this sociocultural valuation allowed us to identify some of the ESs used in the subsequent choice model.

We chose a convenience sampling technique, since our aim was not to extrapolate the results but to gain in-depth knowledge of attitudes and identify key ESs for the economic valuation. A total of 92 questionnaires were collected, 47 from farmers and 45 from non-farmer stakeholders consisting of 15 technicians from the local farmers' federation, 15 people employed in the tourism sector and 15 employed in public administration.

To guarantee the effectiveness of the data collection, we conducted face to face interviews with the farmers and the stakeholders in the tourism sector. The same questionnaire was completed online by the other two categories of stakeholders.

The respondents were asked to express their level of agreement on a 5-point Likert scale with a list of positive and negative effects of the dairy livestock systems on the mountain environment. The positive effects were described as: control of shrubs and forest encroaching on pastures and meadows, maintenance of beautiful natural landscapes, maintenance of traditional cultural landscapes, maintenance of high biodiversity, maintenance of suitable habitats for the conservation of wild animals, maintenance of soil fertility, prevention of soil erosion, prevention of avalanche risk, maintenance of cultural heritage, maintenance of tourism attractiveness and production of high quality food. The negative effects were: water pollution, greenhouse gas emissions, detriment to animal

welfare, soil contamination, soil compaction/erosion, air contamination (odour), production of low quality food and loss of natural vegetation. The categories were: 1 (strongly disagree), 2 (disagree), 3 (neutral), 4 (agree), 5 (strongly agree). The positive and negative effects listed above were classified following TEEB (2010). Stakeholders' perceptions were compared by analysing the data using a Kruskal-Wallis test (PROC UNIVARIATE, SAS, 2011).

Economic valuation of ESs and EDSs of agroecosystems in different scenarios

During the sociocultural valuation, many non-farmer stakeholders expressed concerns about the landscape changes taking place in the valleys as a result of the expansion of vineyards and other permanent crops that were displacing traditional dairy farms. As intensification of agriculture in the valleys is linked to the abandonment of the steepest and less favourable areas (Cocca et al., 2012), we expanded the scope of the second part of our study to include permanent crops (vineyards and fruit trees), thereby taking into account the evolution of the agroecosystems in the study area. Water quality was included as a key regulating ES (or EDS depending of the level of provision) as it was found to be the main environmental concern for non-farmer stakeholders and because water pollution is considered to be the main risk from intensive agriculture (La Notte et al., 2014).

Choice experiment design

Individuals' stated behaviour in a hypothetical choice experiment was used to determine the rank and value of the selected ESs (Alfnes and Rickertsen, 2011; Hensher et al., 2005).. When designing the choice model, we tried to keep the number of relevant attributes (ESs) to be evaluated to a minimum to make it easy for respondents to understand (Hensher et al., 2005). The ES under analysis were: conservation of agricultural landscapes, maintenance of biodiversity and provision of quality local food products linked to the territory and water quality The four ES attributes were assigned three levels described in biophysical terms (Table 1), which corresponded to three policy (land use) scenarios (see Figure 1) (a detailed description of attributes is given Appendix A and the actual choice model is given in Appendix B): (1) intensification-abandonment with lower provision of ESs, (2) the status quo scenario describing the current situation, and (3) sustainable development with higher provision of ESs. The annual cost attribute, treated as a continuous variable, had five levels

in which the status quo corresponded to the weighted average cost per year per person over 18 years of age in the Rural Development Programme (RDP) 2014-2020 for the sampled regions.

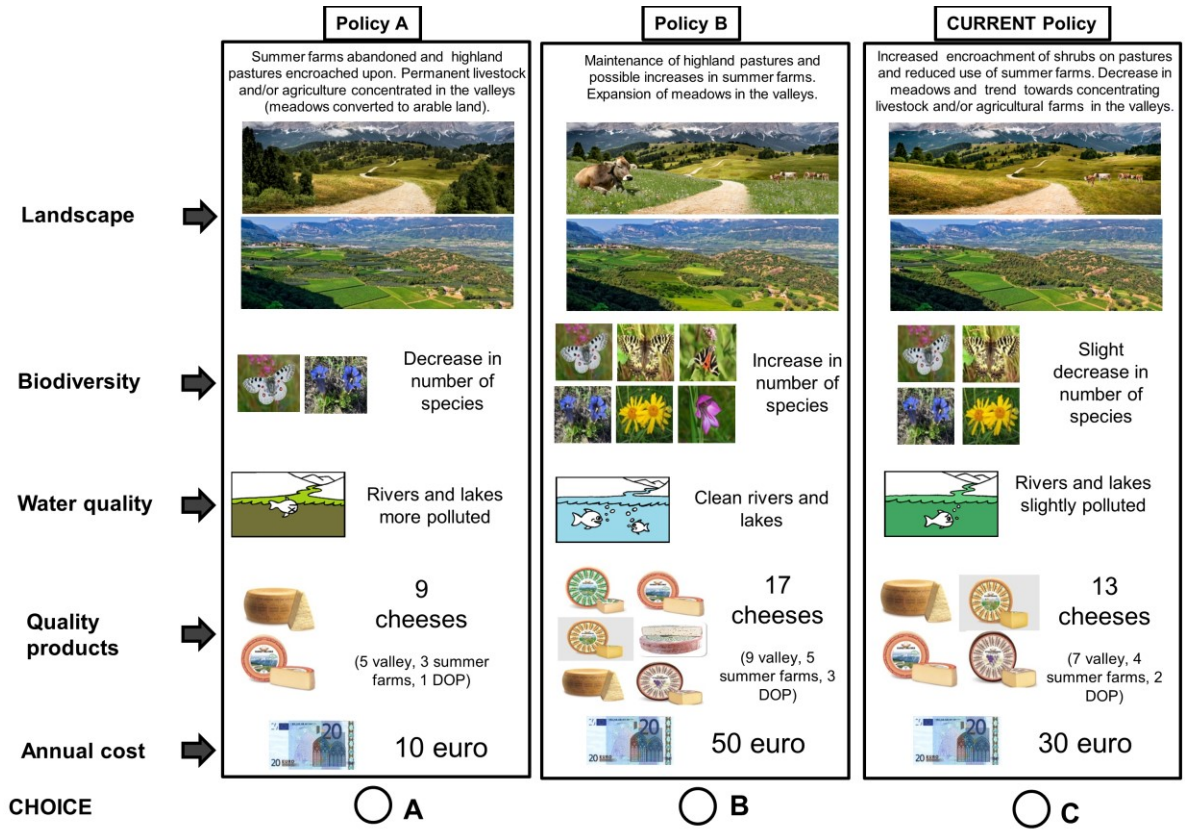
Table 1. Attributes, levels (status quo underlined) and components of the total economic value (TEV) of the choice experiment.

Attribute	Levels (number and coding)	ES type	TEV component
Landscape	1: abandonment (highland pastures) and intensification (valley); 2: current landscape; 3: rich mosaic	Cultural ES (recreation, spiritual/cultural well-being)	Non consumptive direct use value
Biodiversity	1: reduction in floral and butterfly diversity; 2: slight reduction; 3: increase	Supporting ES (preservation of biodiversity)	Non-use existence value
Water quality	1: Rivers and lakes unpolluted; 2: slightly polluted; 3: more polluted	Regulating ES (indirect benefits).	Indirect use value
Quality local products	1: 9 cheeses available; 2: 13 cheeses available; 3: 17 cheeses available	Provisioning ES.	Consumptive direct use value.
Annual cost	5 levels: €10, 20, 30, 40, 50		

Each choice set consisted of three alternative policy scenarios described in terms of the ESs (attributes) and levels (Figure 1). The two hypothetical policy scenarios, A and B, consisted of different combinations of the attribute levels, while the current policy consisted of a fixed combination (see Appendix B). The different combinations of attribute levels were stablished using the Ngene software (Choice Metric, Ltd.) to create an orthogonal design. We checked the resulting combinations to ensure that choice sets did not contain any clearly favourable or unfavourable combinations. Policy scenarios were unlabelled to ensure respondents focussed on the attribute combinations without their choices being affected by policy names.

Given the large number of combinations of attributes and levels ($3^4 \times 5^1 = 405$), we designed an efficient experiment consisting of thirty choice sets split into six blocks, requiring each respondent to make 5 choices. All the ES attributes were treated as categorical variables, whereas the five-level annual cost was treated as a continuous variable. We assumed that the ES selected represented the most important use or non-use values of the total economic value (TEV) (Pearce, 1993), so that the sum of the partial WTPs obtained from the analysis could be considered an estimate of the TEV of the livestock system under consideration. The same choice design with similar scenario definitions has been successfully implemented in other European agroecosystems (for full details see Bernués et al. 2015, 2014).

Figure 1. Example choice set. For the purposes of illustration, the attributes of policies A and B are represented with levels corresponding to the intensification-abandonment (A) and sustainable development (B) scenarios (see Appendix A for details). The actual choice sets presented in the survey comprised combinations of the attribute levels of policies A and B according to an orthogonal design.



Survey and questionnaire

The survey was administered to two different sample populations in order to compare the local population - residents of the Autonomous Province of Trento - with the reference population - residents of the provinces bordering the study area (Belluno, Bolzano, Brescia, Sondrio, Verona and Vicenza). Previous research has shown that familiarity with the study area is important in assessing certain ESs (Chan et al., 2012; Soini et al., 2012), particularly landscape attractiveness. We assumed that the sample designated 'reference population' would be familiar with the study area. Furthermore, the population of the six neighbouring provinces represents 30% of the total population of the provinces of the entire Italian Alps.

In July and August 2016, 102 face to face interviews were held with respondents from the local population over 18 years of age. We avoided sampling the population of the biggest city

(Trento), focussing instead on people living in closer contact with the countryside. We used a non-probability judgement sampling method based on age and gender in four different areas of the province. Participants were interviewed in their workplace or on site. The same questionnaire was administered online in September 2016 to a panel of 402 professional members of the reference population over 18 years of age. The sample was stratified by province and location within the province, with natural fallout of gender and age.

The questionnaire consisted of an introductory section followed by the choice experiment itself (Appendix B). Before presenting the choice sets, we provided a short description of the study area, the ES attributes used to characterize the study area and the cost of current agroenvironmental policies. We stated clearly that each family member above the age of 18 would have to pay this cost as an annual tax. Each respondent was presented with five choice sets.

Data analysis

The analysis was grounded in the Random Utility Theory (Mcfadden, 1974) and the Theory of Value (Lancaster, 1966). The former holds that individuals always select the option that conveys to them the highest level of utility they can expect. The latter holds that the utility that individuals receive from a good or service depends on the utility of their attributes and not only on the characteristics of the good or service *per se*. This is relevant when valuing ESs because most policy decisions do not involve a complete loss or gain in the provision of a particular ES but rather a different level of provision (Bernués et al., 2015). Choice modelling, instead, allows the level of utility or marginal value that an individual gets from a particular good or service to be estimated through its attributes and levels.

We used a mixed logit model (PROC MDC, SAS 2011) to estimate the level of utility or marginal value obtained by an individual from a particular good or service described by its attributes and levels. This type of model allows unobserved preference heterogeneity among respondents to be taken into account. Since each respondent answered five choice questions, we could not assume that their answers were independent of each other. The utility function can be separated into deterministic components (a linear combination of observed attributes) and random components that capture stochastic elements, which are not otherwise taken into account by the deterministic part of the function. Moreover, the mixed logit specification allows for variation in the effect of the explanatory attributes across respondents, excluding annual cost. Effects were coded so the variables were not correlated with the grand mean of the utility function (Hensher et al., 2005).

In this specific case, we examined the relationships between individuals' preferred policy choices (dependent variable) and the levels of the attributes in the alternatives they chose, i.e., maintenance of landscape, preservation of biodiversity, maintenance of water quality and provision of high quality local food products (independent variables). The effect of the attributes on choice probability was evidenced by the parameter estimates. The sign of a parameter value showed the extent to which the presence of an attribute in a policy scenario influenced the probability of choosing that scenario, which increased with a positive value and decreased with a negative one. The respondents' marginal rate of substitution among attribute levels and the marginal WTP estimates were calculated from the relative sizes of the parameters. We divided the value of the estimate for each attribute by the estimate for annual cost to obtain the partial WTP. The partial WTPs of the attributes were summed to obtain the total economic value (TEV).

Results

Sociocultural valuation of ESs

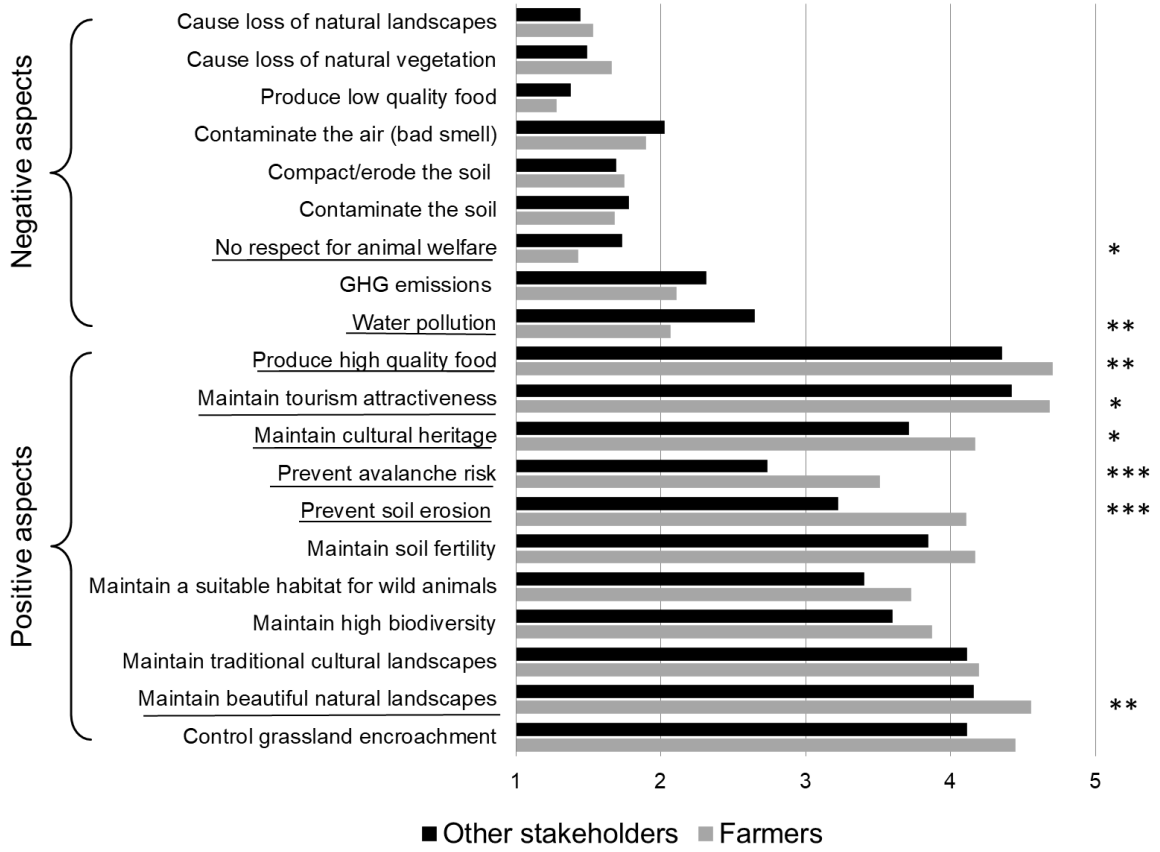
With few exceptions, local stakeholders agreed with the statements concerning the positive effects of dairy livestock systems on the environment and disagreed with all the negative ones (Figure 2).

The most significant difference between the responses of farmers and non-farmers to EDSs (negative effects) regarded water pollution (p <0.05), the farmers strongly disagreeing with this statement whereas the other stakeholders' responses were closer to neutral. In general, concern for animal welfare was low, although non-farmers had greater concern. Respondents tended to strongly disagree (values close to 1) with the other negative aspects, such as loss of natural landscapes and vegetation, production of low quality food and soil compaction/erosion and contamination. They also expressed disagreement (values close to 2) with contamination of the air though bad smells and with GHG emissions.

With respect to the positive relationships between dairy livestock systems and the environment (ES), the statements that received the highest scores were those regarding the production of high quality food, the maintenance of tourism attractiveness and the maintenance of traditional and natural landscapes without grassland encroachment. Farmers rated all these ESs more highly than non-farmers, with very significant differences between

them with respect to the regulating services regarding the prevention of soil erosion and prevention of avalanche risk ($p < 0.001$).

Figure 2. Average levels of agreement and disagreement on negative and positive aspects of mountain dairy livestock systems expressed by farmers and other stakeholders (1: strongly disagree; 2: disagree; 3: neutral; 4: agree; 5: strongly agree). * = p <0.05; ** = p <0.01; *** = p <0.001.



Economic valuation of ESs

The results from the mixed logit model are displayed in Table 2. Most estimates were significant (p <0.001), i.e., the attribute had a significant impact on the respondent's choice, with the exception of both levels of provisioning of quality products for the local population, the high level of provisioning of quality products for the reference population, and the annual cost estimate for the local population.

The sign of the estimates indicated a negative (-) or a positive (+) relationship. All the attributes in the sustainable development scenario were positively estimated by both

populations, meaning that participants obtained welfare gains. Conversely, all the attributes in the abandonment-intensification scenarios were negatively estimated, meaning that participants experienced welfare losses.

Water quality estimates for the reference population were similar in the two scenarios and the largest in absolute value. Biodiversity was next in absolute value and the estimates were also similar across scenarios. Landscape followed in terms of absolute value of estimates, but in this case the estimate for the sustainable scenario was larger. The lowest estimates were for availability of quality products, the higher absolute value being in the abandonment-intensification scenario. The estimate for annual cost was negative and highly significant (P <0.0001), in other words, all else being equal, the respondents generally preferred to pay lower taxes.

Table 2. Mixed logit model results for reference and local population samples

	Local population				Reference population			
Parameter	Estimate[a]	Standard error	*t* Value	*P*	Estimate[a]	Standard error	*t* Value	*P*
Landscape abandonment/intensification	-0.6355	0.1350	-4.71	<.0001	-0.3820	0.0585	-6.53	<.0001
Landscape rich mosaic	1.0630	0.1564	6.8	<.0001	0.6007	0.0646	9.3	<.0001
Biodiversity reduction	-0.5824	0.1483	-3.93	<.0001	-0.6200	0.0733	-8.46	<.0001
Biodiversity increase	0.6330	0.1381	4.58	<.0001	0.6890	0.0622	11.08	<.0001
Water pollution	-1.6774	0.2385	-7.03	<.0001	-1.3880	0.0961	-14.44	<.0001
Good water quality	1.4573	0.2114	6.89	<.0001	1.3559	0.0916	14.81	<.0001
9 quality products	-0.0688	0.1198	-0.57	0.5659	-0.2495	0.06	-4.16	<.0001
17 quality products	-0.1233	0.1221	-1.01	0.3127	0.0787	0.0597	1.32	0.1875
Annual cost	0.00032	0.00811	0.04	0.9689	-0.0171	0.00401	-4.26	<.0001
Model fit								
Number of respondents	102				402			
Number of observations	510				2010			
Log likelihood	-419.52605				-1828			
McFadden LRI	0.2512				0.1722			

[a]Estimated regression coefficients expressing the marginal utility of each attribute level

The estimates for water quality and biodiversity for the local population were generally similar to those for the reference population, although with some specific differences. Firstly, the estimates for the landscape attribute were higher than for biodiversity, especially in the sustainable development scenario. Secondly, as already mentioned the estimates for availability of quality products and for annual cost were non-significant.

The evolution of the estimates across scenarios followed similar patterns for both populations (Figure 3). Water quality increased almost linearly from the abandonment-intensification

scenario to the sustainable development scenario and had the widest range of values. Biodiversity was also nearly linear, but had a narrower range. There was little increase in the landscape estimates from the intensification-abandonment scenario to the current scenario, but there was then a large increase from the current to the sustainable development scenario. The highest value for availability of quality products was in the current scenario, decreasing slightly in both the intensification-abandonment and sustainable development scenarios.

We calculated the TEV only for the reference population as these respondents are representative of the average taxpayer and because the estimate for annual cost was non-significant for the local population. The TEV was €159.30 per person per year in the sustainable development scenario (Table 3), 431% higher than the annual cost in the current scenario. Fifty per cent of the TEV corresponded to the WTP for high water quality in rivers and lakes.

Figure 3. Parameter estimate pathways of ecosystem services in different policy scenarios for local and reference populations.

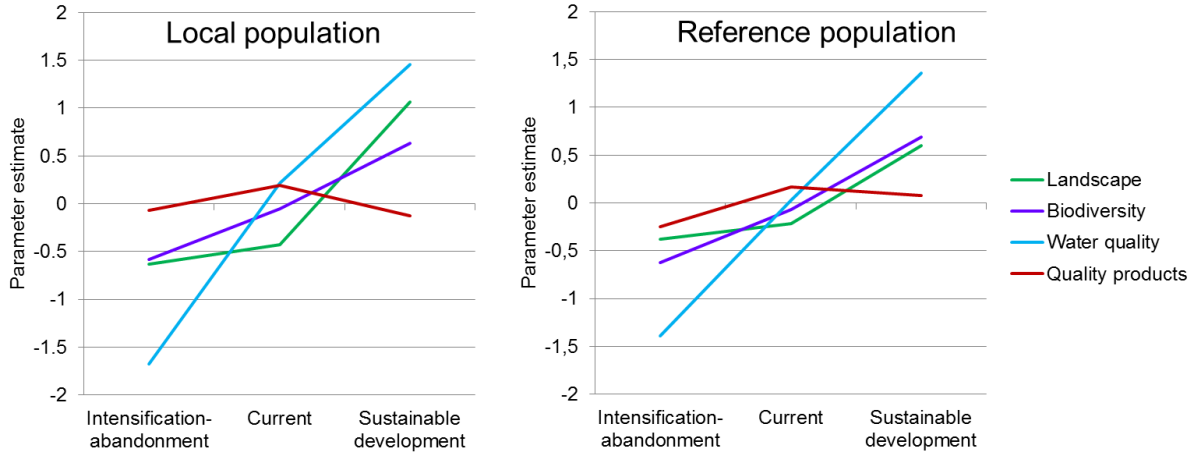


Table 3. The reference population's willingness to pay (WTP) (€ per person per year) and calculation of total economic value (TEV).

ES	Value component of TEV	WTP (€)	WTP (%)
Landscape	Non consumptive direct use	35.1	22.0
Biodiversity	Non-use existence value	40.3	25.3
Water quality	Indirect use	79.3	49.8
Quality products	Consumptive direct use	4.6	2.9
TEV		159.3	100.0

Discussion

Sociocultural valuation of ESs and EDSs delivered by dairy livestock systems

In general, all the stakeholders had a rather positive opinion of the environmental outcomes of the mountain dairy livestock systems and did not rate the negative impacts highly. Few socio-cultural valuations of ESs related to livestock systems have been carried out so far, although other studies confirm that stakeholders tend to have positive perceptions of the presence of grazing livestock (Bernués et al., 2013; Lamarque et al., 2011; Oteros-Rozas et al., 2014) and the practice of transhumance (Oteros-Rozas et al., 2013, 2012). All stakeholders rated a number of cultural ESs (food, tourism, cultural heritage and landscape) as more important than several regulating ESs (avalanches, soil erosion and fertility) and supporting ESs (habitats and biodiversity). This supports the view that cultural ESs should be more closely integrated into planning when preservation of traditional land uses is the objective (Plieninger et al., 2015).

EDS were not recognized, with the exception of some respondents being critical of water quality and GHG emissions. While farmers disagreed with dairy farming causing water eutrophication, non-farmer stakeholders had a neutral attitude. Similar results emerged from another disservice, GHG emissions, which also generated a certain level of scepticism in the non-farmer respondents. Interestingly, this issue has been dealt with extensively in the scientific literature on sustainability in livestock farming in Alpine areas (Battaglini et al., 2014). It seems that both GHGs and water pollution are increasingly perceived by society as problems arising from dairy livestock systems, despite the fact that mountain farming is generically considered multifunctional.

There were other differences between farmers and non-farmers. Farmers rated ESs such as the prevention of avalanches and soil erosion higher than non-framers, and gave low ratings to the EDSs from their activity (e.g. low animal welfare), whereas non-farmers rated them high. Perceptions of ESs have been shown to vary according to socio-demographic factors and individuals' backgrounds and interests (Lamarque et al., 2011; Martín-López et al., 2012; Plieninger et al., 2013).

Economic valuation of ESs delivered by Alpine agroecosystems in different policy scenarios

The relative levels of importance given to the ESs differed across scenarios (Figure 3). Welfare gains linked to water quality, biodiversity and landscape increased in shifting from the intensification-abandonment or current scenarios to the sustainable development scenario. In contrast with these patterns, respondents declared only marginal welfare losses or gains in moving from the current scenario to that with a lower or greater availability of quality products. Similar choice experiments in Spain and Norway found that people considered the availability of high quality products to be very important (Bernués et al., 2015, 2014). However, there were already far more high quality products available in our study area than in the areas examined in these studies, and respondents may have been saturated with or unable to distinguish between so many types. Our results in this respect indicate that the welfare gain linked to the level of provisioning of quality foods is not linear, but has a threshold above which people do not obtain further welfare gains. In addition, they also suggest that people perceived a trade-off between the production of quality products, of which the current level of provision was satisfactory, and the other (especially regulating) ESs. The trade-off between food production and environmental outcomes has been amply described in the literature (Bernués et al., 2016; Feldmann and Hamm, 2015; Guerrero et al., 2009).

Both populations assigned the highest importance to water quality. There are many rivers and lakes in Trento province and these have important recreational functions as well as supplying water to the surrounding non-mountainous provinces. Water quality in the study area is on average good, but is declining locally at various sites and intensive agriculture is regarded as the main pressure (La Notte et al., 2014). The fact that local non-farmers, and especially the reference population, were able to foresee the detrimental effects of worsening water quality better than farmers is problematic, as it is the farmers and their management practices that have the greater impact on this ES.

Biodiversity was ranked second and landscape third in importance by the reference population (although the difference between them was small), and the other way round by the local population. The increase in biodiversity across scenarios was rather linear, although not as intense as the increase in water quality. While people can see the direct effects of water quality on their lives, the consequences of biodiversity loss for human wellbeing are not immediate nor are they easily perceived or understood (Soini and Aakkula, 2007). Both populations perceived a small difference between the current and intensification-

abandonment scenarios with respect to landscape. Bearing in mind that landscape quality is, by definition, subjective (Bernués et al., 2014), this result suggests that respondents did not distinguish between the two levels of landscape attributes as defined in our study. In other words, the current scenario, which displayed the first consequences of the two processes of abandonment and intensification, was judged unacceptable at almost the same level as the abandonment-intensification landscape scenario. However, respondents, especially the local population, showed a clear preference for a more diverse agricultural landscape, as defined in the sustainable development scenario.

Implications for policy design and limitations

In our study, the scenario with the highest delivery of ESs was the most favoured, regardless of the level of production of quality products. Notwithstanding some differences of perceptions, the local and the reference populations clearly rejected the current evolution of agriculture in terms of abandonment and intensification. These findings point at a social preference for 'sustainable intensification', understood as an increase in environmental outputs while agricultural outputs are maintained (Buckwell et al., 2014), at least in mountain and other marginal areas. Grasslands in mountain regions will endure future climate variations which will further threaten their sustainability (Schirpke et al., 2017a); therefore, management strategies that promote their resilience (e.g. preservation of species richness and functional diversity through extensive practices and a heterogeneous landscape (Isselstein et al., 2005; Landis, 2017; Plantureux et al., 2005)), should be at the centre of the future policy design. In Europe, the Common Agricultural Policy (CAP) introduced agrienvironmental measures to reward farmers which proved to care for these environmental issues with their farm management (Schirpke et al., 2017b), however these measures have often been inefficient due to lack of concrete targets, horizontal distribution and lack of monitoring of results (Muradian et al., 2013).

The WTP calculated in this study was more than four times higher than the level of support provided by current agroenvironmental schemes. It was not possible to calculate the TEV for the local population as the annual cost estimate was not significant. Other studies have also shown that societal demand is much greater than policy effort (Bernués et al., 2015; 2014). Actually, in Europe, a large part of mountain farmers' income comes from government supported schemes (Battaglini et al., 2014; Grabherr, 2009). In fact, as Briner et al.(2013a) stated, without subsidies for grassland farming, there is a risk of intensification of farming activities and of further abandonment. WTP results suggest that it is economically feasible to

invest more in support of these practices. In this regard, policy makers should try to consider where to place agriculture along the extensification-intensification continuum according to society's preferences in different agroecosystems and socioeconomic contexts. As farming systems are very diverse and contribute in different ways to ESs (and EDSs), agricultural practices and land use regimes need to be considered at the farm level. Engaging farmers and other stakeholders would help in the search for specific solutions to the distinctive features of the target areas.

We are aware that this study has some limitations. In the first place, we assumed that delivery of a particular ES in biophysical terms was well represented in the policy scenarios. We could also have chosen different representations and indicators to illustrate the ESs, especially for landscape, biodiversity and water quality. An explanation for all the choices is provided in Appendix A. Secondly, it is difficult to convey information to people on the ESs and their levels of delivery, because we are dealing with complex environmental phenomena. We could not really assess people's levels of understanding of the topic or the logical process they used to make their choices. Nonetheless, the results regarding the relative importance of the various ESs are consistent between the populations. Thirdly, calculation of the TEV was based on two assumptions: (1) that the chosen ES portrayed the different value components of the TEV taxonomy; (2) that account would not be taken of option values (those for future use) nor bequest values (those for future generations).

Conclusion

A combination of qualitative and quantitative methods allowed us to explore local stakeholders' perceptions of provisioning, biodiversity, and regulating and cultural ESs and EDSs linked to dairy livestock systems and the environment in Alpine regions, and to assess the economic value that society places on ESs delivered by Alpine agroecosystems. We found evidence that local stakeholders had a positive opinion of the environmental outcomes of dairy livestock systems, although non-farmer stakeholders were more critical of water quality and GHG emissions. Cultural ESs were very important for all stakeholders, which highlights the need to bring them to the fore in environmental planning and management.

Water quality was a key service for both populations. Biodiversity and landscape were ranked second and third in importance by the reference population, and in the reverse order by the local population. These ecosystem services showed an increasing linear trend across scenarios (from the intensification-abandonment to the sustainable development scenario). However, people seemed willing to compromise on the provision of quality food products

when moving across policy scenarios, revealing a potential trade-off between provisioning and other ecosystem services.

The WTP for the ESs provided by Alpine agroecosystems in the preferred sustainable scenario exceeded the current level of public support. It would therefore be possible to take action to support the dairy sector and promote its sustainability, in accordance with the wishes of members of society, who reject the process of agricultural abandonment and intensification currently taking place in many Alpine regions.

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APPENDIX A

Description of attributes and their levels of the choice experiment.

Biophysical indicators for ESs (attributes of the choice experiment)

To best perform a choice model, time is required to identify alternatives, attributes and attributes levels and attributes levels labels (Hensher et al., 2005). Selecting the proper agroenvironmental indicators is a crucial step of the process. To convey relevant information about the ESs in a particular location, indicators should be: (i) intuitive, which means that they have to give clear information easily to be understood by the general public and policy makers; (ii) sensitive to detect changes in the ecosystem status; (iii) accepted from a scientific point of view (Layke, 2009). Hereafter follows a description of the biophysical indicators used to measure the four ESs selected in the sociocultural valuation. The assumptions used in categorizing the multiple functions of traditional mountain livestock farming systems into ES types and into components of TEV are also illustrated.

Alpine agricultural landscape.

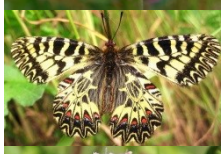
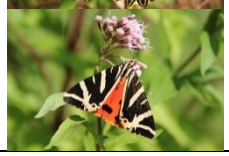
The abandonment and the intensification trends are the two main problems associated with the decline of traditional extensive livestock systems in the Alps. The first occurs in the steepest and less favoured areas, whereas the second one occurs in the most favourable and mechanisation prone lands (MacDonald et al., 2000; Strijker, 2005). Both trends imply a land use change and can occur in parallel in the same area (Battaglini et al., 2014). Consequences involve a general loss of heterogeneity, obtained summing the effects of the encroachment of the steepest patches of grasslands, the transformation of meadows in arable land and the elimination of structural elements (hedgerows, buffer zones, etc.) (Diacon-Bolli et al., 2012; Tasser et al., 2007). Vegetation, land use, form (elements differing from the background) and texture (a reflection of light of surfaces) are the main factors to consider in order to assess the quality of rural landscapes (Ramírez et al., 2011). These variables were manipulated to modify a photo of highland pastures and a photo of a valley. Pictures were found through a web search for images marked for non-commercial use, with

or without modifications. Both images were manipulated using a free version of Adobe® Photoshop® software and GIMP 2.8. The goal was to create hypothetical but realistic landscapes that matched the different land use scenarios. Manipulated aspects were: (a) the extent of forest and shrubs cover; (b) the presence of animals or artificial structure and facilities; (c) management of grasslands (meadows or pastures); (d) heterogeneity of grasslands (form, number and type of patches); (e) texture or diverse land use. Stakeholders in our study higher endorsed functions involved with the maintenance of beautiful natural landscapes that can attract tourists. These functions were gathered into a cultural ESs " agricultural landscape" with a non-extractive direct use value.

Biodiversity

For the sustainable preservation of ecosystem functions, a minimum level of biodiversity is required (Chemini and Rizzoli, 2003). Biodiversity was assessed through floristic and butterfly diversity, which is related to grassland management (Marini et al., 2011, 2009). Plant richness is positively correlated with some families of arthropods and negatively to nitrogen inputs (fertilization) (Kleijn et al., 2009). What is more, some butterfly species needs a specific host plant, for shelter, reproduction or food availability (Curtis et al., 2015). Land use changes, whether driven by intensification or abandonment, are important forces of environmental change and biodiversity loss (Gossner et al., 2016; Stoate et al., 2009). Species selected to describe the ES attribute were taken from the lists in the Directive "Habitat" 92/43/CEE and from lists of National parks present in the study area (Table 1). We choose well-known species to be easily recognized and understood by respondent to the choice model. Besides, species needed to convey actual or potential decline or gain in biodiversity. Moving from the intensification abandonment scenario to the sustainability scenario, biodiversity is first represented only by common species, and progressively by a combination with more rare and endangered species. Stakeholders rated positively the maintenance of a high biodiversity and of habitats suitable for wild animals. In our study, biodiversity was considered as an individual ES (supporting ESs: gene pool protection/ biodiversity conservation).

Table 1. Selected floristic and butterfly species to represent the biodiversity attribute in the choice model.

Species	Pictures	Scenarios		
		abandonment/ intensification	current	sustainability
Gentiana acaulis		✓	✓	✓
Arnica montana			✓	✓
Gladiolus palustris				✓
Parnassus apollo		✓	✓	✓
Zeryntia polyxena			✓	✓
Euplagia quadripunctuaria				✓

Copyright information of pictures:
Gentiana acaulis L., 21.05.2011, © Leo Julen – *uf dr Sunnegga* 2350m, Zermatt;
Arnica montana, http://faune-flore.lu/wp-content/gallery/tiphaine-maurice/arnica-montana.jpg;
Gladiolus palustris, Foto By Hectonichus - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=15610852 ;
Parnassus Apollo, di Hectonichus - Opera propria, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=12573237 ;
Zeryntia polyxena, http://www.naturamediterraneo.com/Public/data9/peppe66/DSCN5843a.jpg_201341314501_DSCN5843a.jpg ;
Euplagia quadripunctuaria By Jean-Pol GRANDMONT - Self-photographed, CC BY 3.0, https://commons.wikimedia.org/w/index.php?curid=27859459

Water quality

Water can be considered a regulating service (water quality regulation), a provisioning service (fresh water supply) and cultural service (recreational use in rivers and lakes). For the purpose of the study, we selected the preservation of water quality as a regulating ES, because it constitutes a good indicator for indirect use value (indirect benefits of ecosystems functions) in the TEV taxonomy. The concentration and intensification of dairy farms in the valleys and the conversion of meadows in arable lands endanger the maintenance of water

quality. In fact, the extra farm feeds required by the higher performances of livestock in the intensive models generates a manure risk not adequate for the assimilative capacity of the swards (Battaglini et al., 2014). Nutrient loading causes eutrophication of surface water and groundwater, while the combination of excessive nutrients and agrochemicals causes changes in water quality (Gordon et al., 2010; Verhoeven et al., 2006). The eutrophication process reveals himself kilometres further than the source of the disturbance, usually in lakes and lagoon.

Quality products linked to the territory

The production of high quality food and the maintenance of tourist attractiveness received the highest scores from farmers stakeholders and were rated very high also from non-farming stakeholders. People tend to associate these products with local culture, traditional heritage, and extrinsic attributes, such as environmental preservation and production site or process (Guerrero et al., 2009; Lenglet, 2014). Since the study area is highly devoted to dairy cattle farming systems, a variable number of quality cheeses available to consumers was considered in the different scenarios. We categorized the functions of dairy mountain livestock systems for producing high quality food and maintain tourism attraction as a provisioning ESs (provision of food and tourism services) with direct use value, going beyond the definition of these products as cultural ESs (cultural heritage).

Land use scenarios (levels of the choice experiment)

Following a previous framework (Cooper et al., 2009) we used as levels in the choice experiment three hypothetical land use scenario, named as “intensification-abandonment policy”, “current policy”, and “sustainable development policy”. The “current policy” constitutes the reference scenario that depicts the Trento Province policy for rural development assuming stability. Trends that have been established in recent years remain stable. The process of abandonment of the less favourable meadows and pastures continues, as well as the intensification of more favourable lands. Permanent farms keep decreasing in number and increasing in size, concentrating in the lower valley, while summer farms are closing or host a lower percentage of lactating cows in the herd. Current grazing pressure modulates but is insufficient to arrest the forest and shrubs encroachment in the steepest, marginal and less productive areas. The “intensification-abandonment policy” scenario is a hypothetical scenario that describes the “liberalization” of the agricultural policy.

The assumption with this scenario is a decrease of support for agri-environmental measures. Less support would accelerate the process of abandonment of summer farms and of small permanent farms, favouring grassland encroachment. The dairy livestock sector would concentrate in the valleys, with few bigger farms using external inputs (such as concentrates) and specialized dairy breeds. Conversion of meadows in arable land is likely in favourable areas more prone to mechanization. On the other hand, the “sustainable development policy” scenario hypothesizes a significant push towards sustainable agricultural policies. Agri-environmental schemes designed to enhance positive functions of the mountain livestock system, minimizing at the same time environmental impacts. A traditional livestock farming systems would be the goal towards which farmers should lead. Supplementary payments would ensure a correct management of grasslands, especially of farther and steepest patches, and therefore the preservation of a traditional landscape and of biodiversity. Besides, small farms would be supported, avoiding land use change of meadows and overloading of nutrients in the low valley. Through the fulfilment of realistic targets, the agri-environmental measures would become Payments for Ecosystems Services, which would compensate tourism for the delivered ESs. We considered the regional Rural Development Programme (RDP) 2014-2020 of the regions involved in the sampling to calculate the social cost of these policy scenarios. Regional population and regional RDP are not homogeneous along the Italian peninsula. To have a realistic picture of the north-eastern of the Alpine area, we specifically took into consideration the RDP of the regions involved in the sampling: the Autonomous Province of Trento, the Autonomous province of Bolzano-Alto Adige, the Lombardia Region, and the Veneto region. Data for the population distribution come from the Italian National Institutes of Statistic (ISTAT). The social cost resulted in 31 euro as the weighted average per year per person above 15 years old.

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APPENDIX B

Questionnaire for the sociocultural valuation of ES and EDS provided by mountain dairy farming

Date_____ Interviewer_____

QUESTIONNAIRE TO STAKEHOLDERS ON DAIRY CATTLE LIVESTOCK AND THE ENVIRONMENT IN THE TRENTO PROVINCE

Introduction

This questionnaire is part of a PhD thesis that tries to evaluate the environment services derived from dairy cattle livestock in the Trento Province. The project is the result of a collaboration between the Department of Agronomy, Food, Natural resources, Animals and Environment (DAFNAE) of the University of Padova, the Federazione Provinciale Allevatori di Trento, and the Centro de Investigación y Tecnología Agroalimentaria de Aragón (CITA) in Spain.

The objective of this questionnaire is to know the opinions of the local population of the Province of Trento around the relationships between dairy cattle livestock and the environment in this area.

Please fill the questionnaire if you live or have lived in the Trento Province or neighbouring.

This questionnaire is absolutely confidential and the information will not be used outside the objective of the project.

Thank you very much for your cooperation!

Questions

In your opinion, what are the main POSITIVE EFFECTS of dairy cattle livestock (animal production, grasslands, etc) on the environment in the Trento Province? (cite or describe briefly as you want)

The raising of dairy cattle in mountainous regions has positive effects because:	1 = Strongly disagree	2 = disagree	3 = neutral	4 = agree	5 = strongly agree
it controls the encroachment of shrubs and forest on pastures and meadows					
it maintains beautiful natural landscapes					
it maintains traditional cultural landscapes					
it maintains a high biodiversity (diversity of plants and animals)					

it maintains a suitable habitat for the conservation of wild animals					
it maintains soil fertility					
it prevents soil erosion					
it prevents avalanche risk					
it maintains cultural heritage					
it maintains tourism attractiveness					
it produces high quality food					
Other (please specify below)					

In your opinion, what are the main NEGATIVE EFFECTS of dairy cattle livestock (animal production, grasslands, etc) on the environment in the Trento Province? (cite or describe briefly as you want)

Please answer these two questions before moving forward in the questionnaire.

1. POSITIVE ASPECTS of dairy cows systems in the mountainous environment. Please, indicate the degree of agreement or disagreement with the following statements.

2. PROBLEMS linked with dairy cows systems in the mountainous environment. Please, indicate the degree of agreement or disagreement with the following statements.

The raising of dairy cattle in mountainous areas has negative effects because:	1 = Strongly disagree	2 = disagree	3 = neutral	4 = agree	5 = strongly agree
it pollutes water (emission of nitrates)					
greenhouse gas emissions(climate change)					
it doesn't respect animal welfare					
it contaminates the soil					
it causes compaction/ erosion of the soil					
it contaminates the air (bad smell)					
it produces low standard quality of food					

it causes loss of natural vegetation (e.g. original forest)					
it causes loss of natural landscapes					
Other (please specify below)					

Do you know or have noticed any change in biodiversity (diversity or abundance of plants and animals) in the area in the last years?

- Yes
- No
- I don't know

3. If you answered YES, could you briefly describe the changes? For example changes in the presence of some animals or plants, etc.
   ……

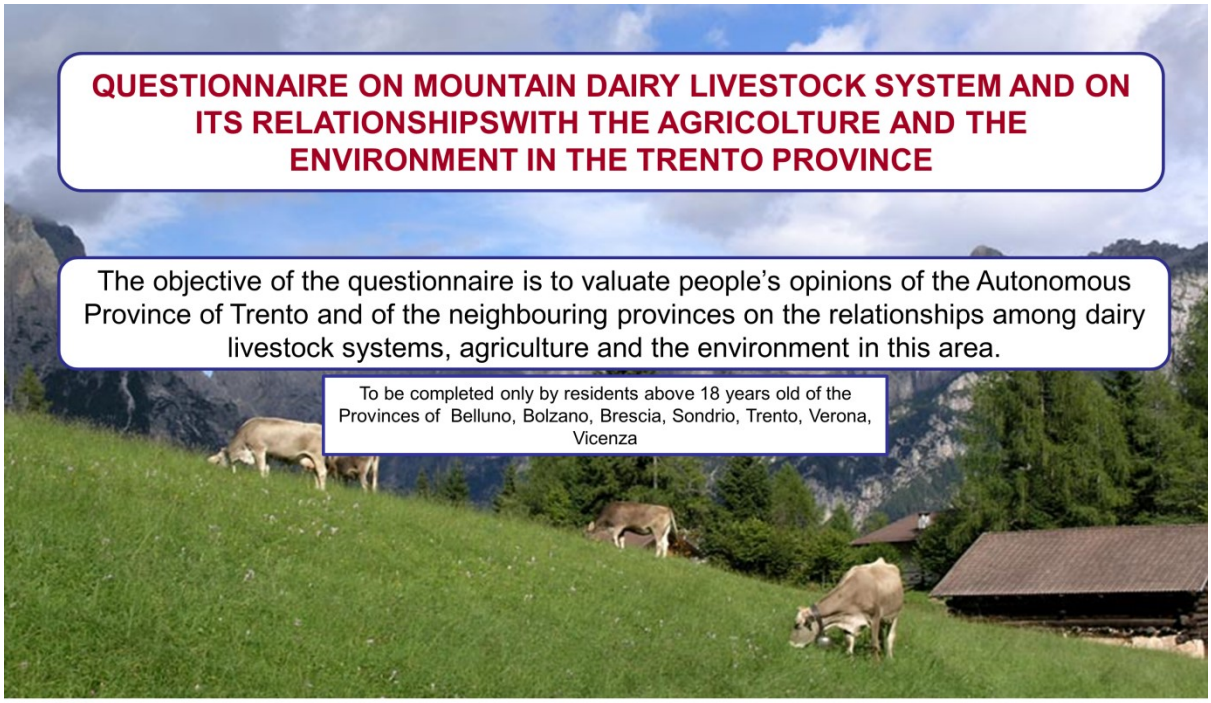
Some personal detail about you:

4. What is the highest level of education you have completed?
   - Primary school
   - Lower secondary school
   - Upper secondary school
   - Higher education/university
5. Which of the following fields best describe your current occupation?
   - Agriculture
   - Environmental management
   - Municipality services
   - Tourism industry
   - Other industry
   - Conservation of heritage
   - Rural development
   - Culture and arts
   - Non-profit organization
   - Other (please specify)
6. If you have any comments or suggestions please write them here.
   …….

Thank you very much for your cooperation.

Choice experiment design

Presentation of one of the six blocks that form the complete experiment design. Every single contestant was presented with an introductory part and one block of sets, that is five choice sets.



Dairy livestock systems in mountainous areas plays an important socio-economic role linked to the production **of quality foods**. In addition, it allows the preservation of an **environment rich in plant and animal species**, as well as a highly attractive landscape from a tourist point of view.

In recent years, traditional farms followed two trends: in the highest and least favourable valleys they have been closed, while in the more favourable areas of the bottom valleys they have been transformed according to intensive and modern production models.

With the closure of traditional farms, the pastures and meadows no longer used are gradually invaded by shrubs and next by the woods. Even in the valley bottom, the areas where modernized farms are concentrating, pastures and meadows tend to decrease because of their conversion into ploughed arable lands. Another problem of concentration of farms in the bottom valleys is that the slurry and manure must be disposed of on a narrower agricultural surface. This leads to a high concentrations of **nutrients in water**, resulting in algal and bacterial growth, oxygen consumption and fish. This process, said eutrophication, manifests itself km away from the source of the disorder, usually in lakes or lagoons.

Both trends (abandonment and intensification) have significant, often unfavourable, effects on the richness of plant and animal species, water quality and aesthetic quality of the landscape.

This questionnaire seeks to **know the opinion** of the local population of the Province of Trento and of the neighbouring provinces on the above mentioned issues.

The aim of the investigation is to provide useful elements for the planning of **agricultural policies and interventions to promote the sustainability of animal husbandry in the territory** of the province of Trento.

Your **participation** is very **important**. We kindly ask you to dedicate a few minutes of your time to complete the questionnaire.

THE INFORMATIONS ARE CONFIDENTIAL AND WILL NOT BE USED OUTSIDE THE AIMS OF THE WORK, NOR PARTICIPANT'S INDIVIDUAL DATA WILL BE PUBLISHED.

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CENTRO DE INVESTIGACIÓN Y TECNOLOGÍA AGROALIMENTARIA DE ARAGÓN

Part 2. Five sets (Please, read this short text carefully before to answer)

Shown below we present **5 sets**.

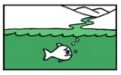
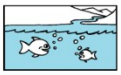
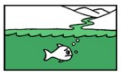
Every set presents 3 **agro-environmental policies** defined by a combination of characteristics of the Autonomous Province of Trento: **traditional landscape** of high mountain and bottom valley**, conservation of endangered species** such as certain types of plants and butterflies**, water quality** and availabiity of **quality foods** linked to the territory.

In every set, the third column correspond to the **current policy** which has a cost of 30€ per year per person above 18 years old. Alternative agro-environmental policies for the territory are taken into consideration. More expensive and cheaper options will be considered.

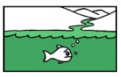
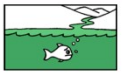
The **cost** corresponds to the amount that each member (above 18 years old) of your family will pay annually on his tax revenue to finance the chosen policy.

For each set, choose the preferred (A, B or C) option

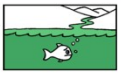
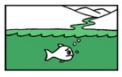
Block 1
Set 2

	Policy A	Policy B	CURRENT Policy
Landscape	Maintenance of highland pastures and possible increases in summer farms. Expansion of meadows in the valleys. 	Summer farms abandonment and highland pastures encroached upon. Permanent livestock and/or agricultural concentrated in the valleys (meadows converted to arable land). 	Increase encroachment of shrubs on pastures and reduced use of summer farms. Decrease in meadows and trend towards concentrating of livestock and/or agricultural farms in the valleys. 
Biodiversity Butterflies and flowers diversity in pastures and meadows	 Increase in number of species	 Slight decrease in number of species	 Slight decrease in number of species
Water quality	 Rivers and lakes slightly polluted	 Clean rivers and lakes	 Rivers and lakes slightly polluted
Quality products	 9 cheeses (5 valley, 3 summer farms, 1 DOP)	 13 cheeses (7 valley, 4 summer farms, 2 DOP)	 13 cheeses (7 valley, 4 summer farms, 2 DOP)
Annual cost	 30 euro	 40 euro	 30 euro
CHOICE	◯ A	◯ B	◯ C

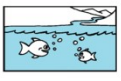
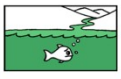
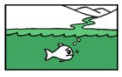
Block 1
Set 6

	Policy A	Policy B	CURRENT Policy
Landscape	Summer farms abandonment and highland pastures encroached upon. Permanent livestock and/or agricultural concentrated in the valleys (meadows converted to arable land). 	Maintenance of highland pastures and possible increases in summer farms. Expansion of meadows in the valleys. 	Increase encroachment of shrubs on pastures and reduced use of summer farms. Decrease in meadows and trend towards concentrating of livestock and/or agricultural farms in the valleys. 
Biodiversity Butterflies and flowers diversity in pastures and meadows	 Decrease in number of species	 Increase in number of species	 Slight decrease in number of species
Water quality	 Rivers and lakes slightly polluted	 Rivers and lakes more polluted	 Rivers and lakes slightly polluted
Quality products	 17 cheeses (9 valley, 5 summer farms, 3 DOP)	 13 cheeses (7 valley, 4 summer farms, 2 DOP)	 13 cheeses (7 valley, 4 summer farms, 2 DOP)
Annual cost	 20 euro	 30 euro	 30 euro
CHOICE	◯ A	◯ B	◯ C

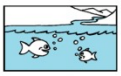
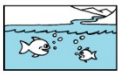
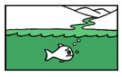
Block 1
Set 8

	Policy A	Policy B	CURRENT Policy
Landscape	Summer farms abandonment and highland pastures encroached upon. Permanent livestock and/or agricultural concentrated in the valleys (meadows converted to arable land). 	Maintenance of highland pastures and possible increases in summer farms. Expansion of meadows in the valleys. 	Increase encroachment of shrubs on pastures and reduced use of summer farms. Decrease in meadows and trend towards concentrating of livestock and/or agricultural farms in the valleys. 
Biodiversity Butterflies and flowers diversity in pastures and meadows	 Decrease in number of species	 Decrease in number of species	 Slight decrease in number of species
Water quality	 Rivers and lakes slightly polluted	 Rivers and lakes more polluted	 Rivers and lakes slightly polluted
Quality products	 13 cheeses (7 valley, 4 summer farms, 2 DOP)	 9 cheeses (5 valley, 3 summer farms, 1 DOP)	 13 cheeses (7 valley, 4 summer farms, 2 DOP)
Annual cost	 40 euro	 30 euro	 30 euro
CHOICE	◯ A	◯ B	◯ C

Block 1
Set 21

	Policy A	Policy B	CURRENT Policy
Landscape	Increase encroachment of shrubs on pastures and reduced use of summer farms. Decrease in meadows and trend towards concentrating of livestock and/or agricultural farms in the valleys. 	Summer farms abandonment and highland pastures encroached upon. Permanent livestock and/or agricultural concentrated in the valleys (meadows converted to arable land). 	Increase encroachment of shrubs on pastures and reduced use of summer farms. Decrease in meadows and trend towards concentrating of livestock and/or agricultural farms in the valleys. 
Biodiversity Butterflies and flowers diversity in pastures and meadows	 Increase in number of species	 Slight decrease in number of species	 Slight decrease in number of species
Water quality	 Clean rivers and lakes	 Rivers and lakes slightly polluted	 Rivers and lakes slightly polluted
Quality products	 17 cheeses (9 valley, 5 summer farms, 3 DOP)	 13 cheeses (7 valley, 4 summer farms, 2 DOP)	 13 cheeses (7 valley, 4 summer farms, 2 DOP)
Annual cost	 50 euro	 10 euro	 30 euro
CHOICE	◯ A	◯ B	◯ C

Block 1
Set 23

	Policy A	Policy B	CURRENT Policy
Landscape	Maintenance of highland pastures and possible increases in summer farms. Expansion of meadows in the valleys. 	Maintenance of highland pastures and possible increases in summer farms. Expansion of meadows in the valleys. 	Increase encroachment of shrubs on pastures and reduced use of summer farms. Decrease in meadows and trend towards concentrating of livestock and/or agricultural farms in the valleys. 
Biodiversity Butterflies and flowers diversity in pastures and meadows	 Decrease in number of species	 Decrease in number of species	 Slight decrease in number of species
Water quality	 Clean rivers and lakes	 Clean rivers and lakes	 Rivers and lakes slightly polluted
Quality products	 13 cheeses (7 valley, 4 summer farms, 2 DOP)	 17 cheeses (9 valley, 5 summer farms, 3 DOP)	 13 cheeses (7 valley, 4 summer farms, 2 DOP)
Annual cost	 30 euro	 50 euro	 30 euro
CHOICE	◯ A	◯ B	◯ C

Chapter 2

Analysis of goals and behaviours of farmers in alpine dairy cattle system

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Submitted

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Abstract

The aim of the study was to analyse farmer's motivations regarding their life and their farm and the connection between objectives and the real management practices in the dairy cattle farm located in a mountain area (Trento Autonomous Province, Easter Italian Alps). First, 46 farmers scored a list of statements on face to face questionnaires regarding their goals for their farming career (using a 5-point Likert scale). They also answered questions on actions that they had performed in the past 5 years. Data on their farm structure and management were also analysed. Secondly, we performed a principal component analyses (PCA) and a cluster analysis on the goals answers. The relationships between clusters and behaviours were tested with a Kruskall-Wallis test. Three factors resulted from the PCA and they were named "quality of life through diversification", "environmental goals" and "economic goals ". Then three clusters of farmers were identified: diversification entrepreneurs (cluster 1, 7 farmers), traditional farmers (cluster 2, 14 farmers) and planner farmers (cluster 3, 25 farmers). The results showed that cluster 1 grouped farmers interested in improving the

quality of life through the diversification of their activity. Farmers grouped in cluster 2 gave a high importance to self-sufficiency and traditional farming aspects, environmental problems and to the self-sufficiency of their farm. Cluster 3 grouped farmers that rated all the economic, environmental and social objectives as important or very important. The analysis highlighted a trade-off between economic aspects and social sustainability that was to the detriment of the social sustainability. Significant differences among clusters were found among variables related to the territory when analysing farm management. The willingness to achieve a set of goals can be affected and delayed by many issues that reduce the differences among farmers actual behaviours. The identification of the heterogeneity of farmers' behaviour is a relevant starting point to enable participatory approaches in order to achieve the sustainable development of the mountain farming system.

Keywords: farmer's behaviour, dairy systems, socio-cultural sustainability, multivariate analysis, mountain

Introduction

It is well known that farmers play a key role in the maintenance of the vitality of rural economies in mountain regions (Baldock et al., 1996). Various of biophysical studies have reported that grassland based livestock systems are essential to the maintenance of the cultural landscape (Olsson et al., 2000; Staaland et al., 1998) and of traditional practices, as for example transhumance (Oteros-Rozas et al., 2014).

Nevertheless, livestock farming in mountains has to face several difficulties (Baldock et al., 1996). Problems like technological development, lack of social infrastructure and significant differences in income levels have pushed farmers to migrate in the last half of the 20th century, increasing depopulation in marginal rural areas (Collantes and Pinilla, 2004; Conti and Fagarazzi, 2005; MacDonald et al., 2000). The abandoning of livestock farming has continued until recent years, mainly caused by a lack of generational succession and/or the high opportunity cost of labour (Bernués et al., 2005). This is the background situation to bear in mind when assessing the sustainability of mountain livestock systems. Previous studies stated that the continuity of small family farms is a key point of the sustainability of this sector (Aldanondo Ochoa et al., 2007; Caballero et al., 2008).

In the past literature on the sustainability of livestock systems, social aspects were often neglected, centring the studies mainly on ecological or economic aspects (Boogaard et al.,

2011; Darnhofer et al., 2010). Recently, however, there has been an increasing focus on the social sustainability, with studies addressing at different scales the problems involving stakeholders of the livestock systems, and focusing in particular on farmers (Bernués et al., 2016; Klopčič et al., 2017; Kuipers et al., 2017; Poulopoulou et al., 2017).

Social sustainability is usually defined at two levels. First, at the farm community level, objectives are related to the well-being of the farmer and his family, i.e., their quality of life, physical, and psychological well-being. Second, looking from the society point of view, external objectives are linked to society's demands, which are continuously changing (Lebacq et al., 2013; van Calker et al., 2007; Van Cauwenbergh et al., 2007). Livestock farms are businesses where decisions are made and implemented largely by a single person. These decisions, crucial for the vitality of the livestock systems in mountain areas, can be determined by many reasons. Different theoretical approaches, known by psychologists for some time, can be used to explain how farmer's goals, objectives and attitudes are determinant factors to understand the farmer's behaviour.

The "Theory of Reasoned Action" (Ajzen and Fishbein, 1975) developed then in the "Theory of Planned Behaviour" by Ajzen, (1991), use beliefs (behavioural, normative, and control) linked with attitude, subjective norm and perceived behavioural control to explain the readiness of an individual to perform a given behaviour. In another theory, the "Transactional Model of Behaviour" (Lazarus and Folkman, 1987), person factors (e.g. personality) and external/physical farm factors (e.g. the environment) contributes together to the shaping of different aspects of farmers' behaviour concerning their business. Hereafter, as reviewed by Edwards-Jones, (2006), studies have used these theories as the base upon which construct a model which could include the adoption of environmental activities (Beedell and Rehman, 2000), environmental and business oriented behaviour (Willock et al., 1999a), technology adoption (Lynne et al., 1995) and the planting of trees (Zubair and Garforth, 2006).

Our objective was to analyse farmer's ambitions for their life and work, and how these matched with their observed behaviours. Therefore we analysed: 1) the objectives and behaviours of farmers regarding their livestock farm; 2) the connection between objectives and the real management practices on the farms.

Materials and methods

Study area

The study area was the Autonomous Province of Trento, located in the north-eastern Italian Alps. It covers an area of 6,200 km^2, with an elevation ranging from 66 to 3,769 m a.s.l.. Meadows and pastures covers 1,139 km^2 (83%) of the Utilized Agricultural Area (UAA) (ISTAT, 2010). The Province is highly devoted to the dairy livestock breeding and almost the totality of the produced milk is processed by local social dairy factories (Sturaro et al., 2013). During summer, replacement and part of the lactating cattle move to highland pastures in temporary units, called “summer farms”, to exploit forage resources not available during the rest of the year. In the period 1980-2010, dairy farms decreased in number, from 5749 to 1071, and contemporary increase the average herd size, from 5.0 to 20.2 cows/farm in 1980 and 2010, respectively (ISTAT, 2010).

Questionnaire and data collection

Forty-six farmers were contacted in the local trade annual fair and through dairy cooperatives collaboration. We collected information using a closed questionnaire that was completed on average in 30 minutes. Instructions were supplied by a moderator who had the possibility to clarify any doubt of the participants in public.

The theoretical planning of the questionnaire was based on the theoretical framework of the transactional model of behaviour (Lazarus and Folkman, 1987). The first part of the questionnaire contained general information of the farmer (name, age, the highest level of education completed) and general situation of the farm (age of the farm, years of managing, utilized agricultural area or UAA). The second and the third part of the questionnaire contained questions on objectives and behaviours. Further information on management and production variables were retrieved from a previous database (Sturaro et al., 2013) collected in the same study area. Missing or incomplete information was recovered during the interviews.

Guided by the literature reviewed on Willock et al. (1999), we identified farming objectives relating to success, conservation attitudes, quality of life, and off-farm work. Two to ten items were composed to describe each of those areas, adding to a total of 23 statements. We used a 5-point Likert scale: (1) very unimportant; (2) not important; (3) neutral; (4) important; (5) very important. Since we suspected overlap of item domains, it was assumed that the initial

large number of items would need to be reduced by factor analysis. Items were randomly scattered throughout the questionnaire in an attempt to elicit “true” replies by preventing the imposition of cognitive consistency on responding to a series of items. The instruction given was: “Please, score the following statements on the basis of the degree of importance, from 1 very unimportant to 5 very important. You should rate the statements according to your own farming career“. Instructions for this section of the questionnaire made it clear that farmers should report goals and values held with respect to their own farming career.

Success. Success related to the financial status of the business, the intrinsic qualities of the farm and to having pride in the farm enterprise, as indicated by items such as “It is important to keep buildings, equipment and machinery in good condition”, “it is important to successfully participate at dairy shows”, and “ it is important to adopt the best new technologies and methodologies available”.

Conservation. These statements were related to farmer’s concern for the environment. An individual scoring high on this domain would agree with items as “It is important to reduce the amount of nitrogen emitted from the farm”.

Quality of life. Farmers reported important goals beyond those associated with the farm enterprise. These objectives emphasised personal development and family life. A person with a high score on this dimension would score highly with the items “It is important to improve the living standards of your family” and “It is important to have other dedication outside farming”.

Off-farm work. The items in this section account for the dimension related to diversification in farming. Endorsing statements like “It is important to start or increase investments outside the farming sector (e.g. tourism).

In addition, we identified 25 statements related to four farming behaviour: business-oriented, environmental-oriented, stressed and traditional behaviours. The instructions were: “Please report if you performed or not these actions in the past five years”. The answers to the questions were dichotomic depending on the question (Yes, no; if yes: increase, decrease).

Business-oriented behaviour. These questions were related to keeping records, setting targets, maximising profits and detect changes in utilized agricultural areas.

Environment-oriented behaviour. Farmers answering positively in this domain were likely to be active in conservation and to have undertaken some management on their farm in the last five years which would enhance its conservation status.

Stressed behaviour. Questions were thought to measure the stress level of farmers from a financial and a personal point of view.

Traditional behaviour. Farmers answering positively to these questions would adopt behaviour that distances their farm to the traditional farming style of the study area.

Data analysis

The differentiation listed above of objectives and behaviours in domains was useful for the creation of the questions. They have to be considered as general indications for a further interpretation. This mixture of theory and empiricism led to a set of variables whose association was analysed using multivariate statistics to explore the relationship among objectives, behaviours, management and production variables.

Through Principal Component analysis (PCA) (PROC FACTOR, SAS 2011) we were able to detect the relationships among variables and to reduce consistently the data matrix thanks to the creation of new groups of variables or factors, which count for the greatest amount of original variance. Factors represent a basal situation that summarizes the previous set of variables. We retained only factors with eigenvalues greater than 1. We performed PCA analysis on objectives, identifying 3 factors. Using these factors, we did a hierarchical cluster analysis to identify homogeneous groups of farmers that were compared for farming objectives, farmer's behaviours and management practices. We performed the Kruskal-Wallis test (PROC NPAR1WAY, SAS 2011) to analyse differences among clusters.

Results

The descriptive statistics of farmers profiles, farm management and productive variables are reported in Table 1. Interviewed farmers were on average quite young and had a medium education level, corresponding to high school. Farms were on average old enough hold more than one generation of farmers. We sampled farms with different sizes which are reflected by the UAA (45 ± 52 ha). Less than a half of the farms used tied stables. Very few of them used the total mixed ratio and almost no one used the silage. This is due to the fact that the livestock sector in the area is strongly linked to the production of PDO cheeses, which forbid the use of silage (Bittante et al., 2011). In the study area, all farmers brought replacement cattle to the summer farms and more than a half of them continued to bring also lactating cows. The milk production was on average of 22 kg cow/day. Each farm has on average a

medium size herd (41 ± 28 dairy cows). In the study area, it is common to have mixed herds. The average incidence of breeds in our sample showed that the Brown Swiss was the preferred breed, followed by the dual purpose Italian Simmental and the Holstein Friesian. There was also a small percentage of local breeds. The average farm was situated at a high elevation (866 ± 213 m a.s.l.) and had an intermediate herd size (Livestock Unit, LU, per farm) and a stocking rate (2.0 LU/ha). The ratio of ha of meadows per LU is an indicator of the management of meadows and open areas. It indicates that for each LU the farm managed half a hectare of grassland. For the questionnaire we contacted farmers from different valleys of Trento Province: the comparison of the sampled farms with the average characteristics of dairy farms in Trento Province (Sturaro et al., 2013) confirms the large variability of management practices, although only farms with more than 10 dairy cows were involved in this survey.

Table 1. Descriptive statistics of averages of farmer's profile, management and production variables.

FARMERS PROFILE	μ ± SD
Age (years)	41 ± 11
Education level (1=low or elementary school; 2=average or high school; 3=high or university level)	1.9 ± 0.7
STABLE MANAGEMENT	
Age of the farm (years)	51 ± 27
Years of management	16 ± 11
UAA (ha)	45 ± 52
Tied stable (0=no,1=yes)	0.4 ± 0.5
Total mixed ratio (0=no,1=yes)	0.2 ± 0.4
Use of silages (0=no,1=yes)	0.1 ± 0.3
Summer farm with dairy cows (0=no,1=yes)	0.6 ± 0.5
Milk production (kg cow/day)	22 ± 5
ANIMAL	
Number of dairy cows	41 ± 28
Mean incidence of Brown Swiss (%)	36 ± 38
Mean incidence of Holstein Friesian(%)	14 ± 24
Mean incidence of Italian Simmental (%)	15 ± 29
Mean incidence of local breeds (%)	28 ± 42
TERRITORY	
Elevation of the farm (m a.s.l.)	866 ± 213
Livestock unit (LU)	53 ± 34
Stocking rate (LU/ha)	2.0 ± 1.9
Ha meadows/LU	0.5 ± 0.2

Three factors related to farmer's objectives were identified (Table 2). Factor 1, *quality of life through diversification*, included objectives related to the diversification of the farm and of the life of the farmer, having, for example, another dedication outside farming. It included also the aim to improve the living standard of the farmer's family. Factor 2, *environmental goals*, included objectives related to the environment, to the tradition and self-sufficiency of the

farm. Factor 3, *economic goals*, included objectives related to the self-sufficiency as well, but strongly related to the economic management of the farm.

Table 2. Rotated Factor Pattern obtained in the PCA of farmers' objectives.

How important is for you ….	**Factor 1**	**Factor 2**	**Factor 3**
to improve the living standards of your family	**69**	33	10
to have other dedication outside farming	**77**	-9	-8
to have a diversified farm	**76**	-13	4
to reduce the amount of nitrogen emitted from the farm	-22	**73**	-1
to keep using summer farms	20	**76**	-10
to maximize the use of your own farm resources	-2	**65**	**50**
to make the largest possible profit	-16	1	**72**
to minimize management costs	24	-2	**78**
Eigenvalue	**1.91**	**1.76**	**1.22**
Variance (%)	**1.82**	**1.67**	**1.39**

Printed values are multiplied by 100 and rounded to the nearest integer. Boldfaced and underlined values indicate factor loadings above 0.4.
[a)]Factor 1 = quality of life through diversification
[b)]Factor 2 = environmental goals
[c)]Factor 3 = economic goals

The 3 factors resulting from the PCA of objectives were used to segment our sample in 3 clusters. To better describe them, we show in Table 3 the significant objectives that characterize their differences. Cluster 1, named "Diversification entrepreneurs", included 7 farmers that checked as very important or important objectives related to economic aspects of management, to the diversification of the farm and to the improvement of the quality of life of their families. At the same time, diversification entrepreneurs marked as not important objectives related to the environmental impact of the farm. Cluster 2, named "*Traditional farmers*", scored as very important just three objectives that are related to self-sufficiency using the traditional management system. They checked as important also the environmental objectives, whereas they signed as not important objectives related to the diversification of the farm and of their activities. Cluster 3, named "*Planner farmers*", checked all the objectives as important or very important.

Only three behaviours resulted significant among clusters. Diversification entrepreneurs, cluster 1, moderately invested in facilities and machinery. They all took holidays and they decreased the amount of concentrates per cow. All the farmers included in clusters 2 and 3 increased or improved in the past 5 years the facilities and machinery of their farms. Less than a half of them took holidays and they did not modify the amount of concentrates per cow.

Table 3. Significant results of the Kruskal-Wallis test on clusters and objectives.

OBJECTIVE	CLUSTER			
	1 (n=7)	2 (n=14)	3 (n=15)	p
To reduce nitrogen emissions	2.71	3.93	3.8	*
To reduce the purchase of feeds	2.86	3.57	3.84	*
To be able to take more holidays	3.86	2.57	3.8	*
To make the largest possible profit	3.43	3.79	4.4	*
To keep using summer farms	4	4.57	4.72	*
To improve living family standards	4.14	3.57	4.64	*
To have other working skills outside farming	4	2.64	3.68	*
To maximize the use of your own farm resources	3.43	4.36	4.8	*
To have other dedication outside farming	4.14	2.79	3.76	*
To use livestock breeds adapted to mountain pastures	2.86	3.64	4	†
To minimize management costs	4.14	4	4.88	*
To plan for retirement	4	2.79	3.6	†
To have a diversified farm	4.14	2.71	4	*
	Diversification entrepeneurs	**Traditional farmers**	**Planner farmers**	

The answers followed a 5-point Likert scale: (1) very unimportant; (2) not important; (3) neutral; (4) important; (5) very important. * = 0.01<p<0.05; † = 0.05<p<0.10.

Table 4. Significant results of the Kruskal-Wallis test (p<0.05) on behaviours related to the previous 5 years.

VARIABLE OF BEHAVIOURS	CLUSTER		
	1(n=7)	2(n=14)	3(n=25)
Did you increased or improved facilities and machinery?[a]	0.57	0.93	0.92
Did you take holidays?[a]	1	0.3	0.4
Did you modify the amount of concentrates per cow?[b]	-0.43	0.07	0.16

[a] 0 = No; 1 = Yes
[b] -1 = decreased; 0 = no modification; 1 =increased

Variables related to the number of dairy cows, stocking rate and the ratio of ha of meadows per LU proved to be significant. Cluster 2 had the minimum number of dairy cows per farm and the minimum stocking rate. It was also the cluster that managed the highest ha of meadows per LU. Cluster 1 presented opposite results of Cluster 2. Cluster 3 showed a similar number of animals per farm as Cluster 1 but presented an average situation compared to the other cluster on the other two significant variables. The analyses highlighted also trends concerning the education level, the elevation of the farm and the LU. Cluster 3 had the highest education level. Cluster 2 had farms located on higher elevations and had the lowest LU.

Table 5. Results of the Kruskal-Wallis test for the farmer's profile, the management and the production variables.

VARIABLE	CLUSTER			
	1 (n=7)	2 (n=14)	3 (n=25)	p
FARMER'S PROFILE				
Age (years)	40.42	43.64	38.76	NS
Education level (1=low or elementary school; 2=medium or high school; 3=high or university level)	Low-average[b]	Low-average[b]	average[a]	†
STABLE MANAGEMENT				
Age of the farm (years)	62	49	49	NS
Years of management	14	17	17	NS
UAA (ha)	36	36	53	NS
Tied stable (0=no,1=yes)	0.14	0.57	0.38	NS
Total mixed ratio (0=no,1=yes)	0.14	0.14	0.23	NS
Silage (0=no,1=yes)	0.14	0.07	0.07	NS
Summer farm with dairy cows (0=no,1=yes)	0.57	0.71	0.61	NS
Milk production (kg head/day)	24.71	20.48	22.28	NS
ANIMAL				
Number of dairy cows	46.71[a]	27.78[b]	47.19[a]	*
% Brown Swiss	39.01	28.82	40.45	NS
% Holstein Friesian	22.98	9.35	13.87	NS
% Italian Simmental	14.17	16.83	14.27	NS
% local breeds	22.42	34.06	26.75	NS
TERRITORY				
Elevation of the farm (m a.s.l.)	846[b]	917[a]	832[b]	†
LU	62.62[a]	36.63[b]	59.75[a]	†
Stocking rate (LU/ha)	2.85[a]	1.62[b]	1.91[ab]	*
Ha meadows/LU	0.33[b]	0.54[a]	0.48[ab]	*

* = 0.01<p<0.05; † = 0.05<p<0.10; NS = not significant

Discussion

All farmers shared the willingness to improve the living standard of their families, but each cluster had a different vision of the pathway to follow. Cluster 1 aimed at the diversification as a key strategy to improve the farm activities and their own work skills. The environmental issues were not among their priorities, so the reduction of the amount of concentrates per cow is a business choice which aims to avoid the dependence on external food supplies, to improve the management of the farm resources and to minimize the costs. These management choices and the moderate investment on machinery and facilities in the past 5 years allowed them to take holidays, translating into actions their goals of life improvement for the family. In contrast, Cluster 2 and 3, which were the 85 % of the sample, invested in machinery and facilities improvement of the farms and did not take holidays in the past five years. We could assume that traditional and planner farmers prioritized the modernization of their farms giving up to holidays in the years of the investment. A poor balance between work

time and leisure time affects also one's family and social life when work does not leave enough time for them (OECD, 2015). The behaviour in this case contrasted with farmer's personal objectives, probably creating some amount of stress, and thus decreasing the social sustainability of their activity.

Even if Cluster 2 and 3 judged as important the environmental objectives and the self-sufficiency of the farms, they didn't show behaviours which could differentiate their management, in environmental terms, from the first cluster. Instead, the variables that linked the farms to the territory discriminated better than behaviours the three clusters. In this case, traditionalist farmers presented a management in tune with their objectives, with a low stocking rate and a higher maintenance of open areas and meadows. One reason for the rather uniform behaviour in the sample could be that in the study area exists a singular farmer's association with a common technical assistance system.

Moreover, the goals of farmers help to explain their behaviour, which is also influenced by psychological factors (Willock et al., 1999a). Objectives, values and attitudes are heterogeneous, and so the behaviour and management styles resulting are changing as well (Brodt et al., 2006; Karali et al., 2013; Schmitzberger et al., 2005). The interviewed could declare to pursue an objective and never had the chance to apply it in the past. The process of translating personal objectives into actions could be a work in progress for many reasons, as the need for extra time or economic resources, the lack of enough motivation or willingness to go through all the necessary steps to obtain the results, etc. As a consequence, we could detect few matches between declared goals and actually declared behaviours, but we obtained information about the actions that farmers would be willing to take as soon as they have the necessary conditions.

Previous research on livestock systems highlighted the complexity of the decision-making processes of farmers. It was shown that management practices varied consistently according to objectives, knowledge, values, projects, environmental limitations, specific farm characteristics, applied technology, workloads and other factors (Darnhofer et al., 2010; Errington and Gasson, 1994; Gibon et al., 1999). Results are coherent with a previous study by Vuillot et al. (2016), which suggested that farmers' ways of thinking and ways of farming were linked. Willock et al. (1999a) found that there was an association between quality of life and conservation objectives. Assuming that conservation goals match the environmental objectives in our questionnaire, Cluster 2 and 3 seemed to follow this path. However, we found that quality of life was connected more with diversification for Cluster 1. It was apparent that the same objective can be pursued by different ways.

Moreover, if we review other studies conducted on a broader scale, comparing farmers or stakeholders from different countries, we can deduce that the effect of the country of origin

counts more than the differences among stakeholders (Klopčič et al., 2017; Kuipers et al., 2017). The scale for a social sustainability analysis should be relatively small, at a local or regional level, to optimize the possibilities to detect differences among stakeholders, in order to produce a relevant tool to understand the reasons behind farmer's actions and to communicate and cooperate with on this particular the territory. Large-scale assessments may conflict with the findings of micro- or meso-scale data sets (Lambin et al., 2001). Since micro- or meso-scale data sets are specific to time and place, they do not impact on the global debate but they become relevant when developing a local land use policy. A proper land use policy should include socio-economic drivers, biophysical drivers, and also human-environment conditions, as suggested also by Mattison and Norris (2005). In summary, policy making need to take into account the farmers heterogeneity and regional context to be effective and to increase the social sustainability of the livestock sector involved.

Conclusion

The multivariate analysis applied to information obtained via face to face questionnaires allowed us to investigate difficulties of livestock farming in mountains areas, and, more specifically, to unravel the personal goals of farmers and the connection between them and the actual behaviours on their farms. Farmers shared common values, like the strong willingness to improve their family's living standards, but they were following three different pathways to reach them. Besides, the majority of farmers struggled to find a balance between work time and leisure time, probably related to economic difficulties. The comparison between farmers' objectives and the real management practices in the farms showed that there are differences, but objectives do not seem to be the main driver in the definition of the farming systems (although our sample was limited). External factors, like CAP reform, socio-economic context, cooperation strategies, etc. also influence the choices of the farmers. This mild link between farmers' objectives and farm management risks eroding the satisfaction of the main stakeholders of the livestock sector, which play a fundamental multifunctional role in mountain agroecosystems. When taking into consideration variables related to the management of the territory, traditional farmers were in tune with their objectives, with low–impact practices that favoured the maintenance of open areas and meadows. The results of this study provide useful elements for the implementation of effective management strategies and policies for rural development based on participatory approaches, aiming to incorporate the different ambitions of farmers. In fact, with this approach, it is possible to gather information about the actions that farmers would be willing

to take as soon as they have the necessary stimuli to do them. Designing policies that take into account farmers' background is an important preliminary step for a more effective support and collaboration between policy makers and farmers.

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APPENDIX A

Date_____ Interviewer_____

QUESTIONNAIRE TO FARMERS ON DAIRY MOUNTAIN LIVESTOCK AND ENVIRONMENT IN THE TRENTO PROVINCE

7. General information of the farmer

   Name and surname_____

   Age_____ Identification farm number (Code ASL and/or AUA)_____

   _____

   Municipality of the farm_____

   Highest level of education completed:

   - Primary school □
   - Lower secondary school □
   - Upper secondary school □
   - Higher education/university □

8. Situation of the farm

   How old is the farm?_____

   How many years have you been managing the farm? _____

   SAU of the farm_____

   Do you bring your animals to summer farms? □ Yes □ No

   Do you send your lactating cows to summer farm? □ Yes □ No

   If yes, have you changed the amount of animals that you bring to summer farms in the last 5 years? □ No □ Yes, If yes… it increased □ , it decreased □

FARMING OBJECTIVES

Instructions: Please, score the following statements on the basis of the degree of importance, from 1 very unimportant to 5 very important. You should rate the statements according to your own farming career.

Questions: How important is for you…	**1 very unimportant**	**2 not important**	**3 neutral**	**4 important**	**5 very important**
to successfully participate at dairy shows					
to maintain pastures and meadows in a good condition					
to start or increase investments outside the farming sector (e.g. tourism)					
to reduce the use of antibiotics					
to reduce the amount of nitrogen emitted from the farm					
to reduce the purchase of feeds					
to be able to take more holidays					
to adopt the best new technologies and methodologies available					
to make the largest possible profit					
to keep using summer farms					
to pass on the farm to a member of the family					
to keep the welfare of cows					
to reduce the working hours on the farm					
to improve the living standards of your family					
to keep buildings, equipment and machinery in good condition					
to have other working skills outside farming					
to maximize the use of your own farm resources					
to have other dedication outside farming					
to use livestock breeds adapted to mountain pastures (e.g. Rendena; Alpine Grey; Simmental)					
to minimize management costs					
to plan for the retirement					
to have a diversified farm					
to have the respect of neighbours and other farmers					

FARMER BEHAVIOUR

Instructions: Report if you performed or not these actions in the past five years.

Questions:

- Did you quit taking the animals to the summer farm? □ Yes □ No
- Did you change the general management of the farm significantly? □ Yes □ No
- Did you start a new feeding system? □ Yes □ No. If yes, which one?
- Did you increase milk production per cow? □ Yes □ No. If yes, how much?_____
- Did you change towards a more extensive farming? □ Yes □ No

- Did you switch to organic farming? □ Yes □ No
- Did you start or expand the tourism business? □ Yes □ No
- Did you increased or improved facilities and machinery? □ Yes □ No
- Did you have problems to fulfil your financial commitments? □ Yes □ No
- Did you register farm revenue and outflows? □ Yes □ No
- Did you take holidays? □ Yes □ No
- Did you use targets in managing the farm? □ Yes □ No
- Did you reduce the number of meadow cuts during bird nesting? □ Yes □ No
- Did you take new loans? □ Yes □ No
- Did you reduce nitrogen leaching from the effluents of the farm (the Nitrates Directive)? □ Yes □ No
- Did you change breed? □ Yes □ No
- Did you start a major technical innovation? □ Yes □ No. If yes, which one?_____
- Did you change the use antibiotics and/or chemical fertilizers?
  □ Yes □ No, If yes… it increased □ , it decreased □
- Did you change the pasture surface?
  □ Yes □ No, If yes… it increased □ , it decreased □
- Did you change the meadow surface?
  □ Yes □ No, If yes… it increased □ , it decreased □
- Did you change grazing areas or grazing periods?
  □ Yes □ No, If yes… it increased □ , it decreased □
- Did you modify the amount of concentrates per cow?
  □ Yes □ No, If yes… it increased □ , it decreased □
- Did you change the herd size?
  □ Yes □ No, If yes… it increased □ , it decreased □
- Do you crossbreed your herd with beef breeds to sell calves? □ Yes □ No
- Do animals for the restock of your cow herd come mainly from your farm?
  □ Yes □ No
- Any other relevant change you want to mention

  _____

  _____

  _____

Chapter 3

Delving in mountain farming vision of Ecosystem Services: a focus group approach

Abstract

The aim of the study was to analyse the awareness of stakeholders on the relation between local dairy supply chains and Ecosystem Services (ESs) in Austrian and Italian mountain areas. A specific aim was to understand stakeholder's opinion on the opportunities given by the Mountain Product EU regulation to generate added value, and on the needs of this sector in terms of communication strategies. First, we performed a stakeholder analysis through the snowball sampling method. Second, we developed an online survey to discover stakeholder's background knowledge of Ecosystem Services (ESs) and to design the following step, which was a focus group. This procedure was performed for each one of the study areas. We found that stakeholders had a positive vision of the effects of the livestock production chain on the mountain environment and vice versa. There was some discordance on possible null or negative impacts among the Austrian and Italian stakeholders. Focus groups highlighted common difficulties and opinions. Collaboration among stakeholders was highly suggested to improve a targeted communication of added value and of positive externalities (ESs) generated with the maintenance of the dairy production chains in mountain areas.

Keywords: mountain product, ecosystem services, added value, participatory approaches, dairy farming

Introduction

Important changes have occurred during the last half of the 20th century in the alpine territory, on the one hand, due to the intensification of agriculture in favourable areas and, on the other hand, to the progressive reduction or abandonment of traditional livestock systems had various consequences on the local scale (MacDonald et al., 2000; Strijker, 2005).

Besides, mountain farming always had to face a series of unfavourable natural situations which complicate the production process, such as the steep gradients of the farmed areas, shorter growing season, the extreme weather conditions, an absence of alternative production possibilities, and poor transport and infrastructure conditions (Floor Brower, 2004).

The consequences of abandonment are manifold, going from a gradual encroachment of shrubs and trees on meadows and pastures (MacDonald et al., 2000; Tasser et al., 2007),to the loss of grassland biodiversity (Benton et al., 2003), the increase of risks of erosion and avalanches (Newesely et al., 2000; Stoate et al., 2009), the landscape homogenisation and loss of cultural landscapes, traditional management techniques and knowledge (Lasanta et al., 2015). These issues affect deeply the economy of mountain areas, causing a lack of employment opportunities, depopulation and an over ageing trend (Conti and Fagarazzi, 2005). In the past this abandonment process has been underestimated from the social and economic point of view, with a lot of studies focusing mainly on the environmental impacts, leading to an imbalance between the three dimensions of sustainability (Darnhofer et al., 2010).

What is more, mountain farming is multifunctional and sustains the management of Ecosystem Services (ESs), which are defined as the direct and indirect contributions of ecosystems to human well-being, many of which do not have a market value and are ignored within evaluation frameworks (Rodríguez-Ortega et al., 2014). The formal framework classifies the ESs into four groups: provisioning ESs, which are material or energy outputs (e.g. food, water, fuel, timber, fibre); regulating ESs, which are biophysical processes (climate regulation, flood prevention, waste treatment and water purification); cultural ESs, which are recreational, aesthetic and spiritual benefits provided by ecosystems; and supporting ESs, which are the processes underneath the production of all the other ESs (soil formation, photosynthesis or nutrient cycling) (Groot and Wang, 2010; Rodríguez-Ortega et al., 2014).

The provision of ESs would be compromised with a modification or intensification of traditional farming practices. In fact, the use of resources and the intensity level of the agricultural systems can deliver ESs or ecosystem disservices (EDS) (Bernués et al., 2011; Steinfeld et al., 2006). The welfare gain or loss associated with the provision or not of a particular ES depends on how stakeholders value the ES, and thus the value perception can possibly affect policy changes (van Oudenhoven et al., 2012). Identifying stakeholder's opinion and point of views allows to improve the understanding of the relationship between human activities and the ecosystem (Chan et al., 2012) and also to identify eventual intervention points for problem-solving (Martín-López et al., 2014, 2012). Deliberative

valuation approaches are suitable to reveal societal motivations for conserving ES (Parks and Gowdy, 2013) and public participation is considered fundamental to the success of conservation policies (Fischer and Young, 2007).

The aim of this study was to explore the relationship between local supply chains in mountain areas and Ecosystem Services (ESs) and to understand to which extent the added value generated by this combination is communicated. The survey involved stakeholders of the dairy livestock production chain in mountain areas of Italy and Austria. The study had the following steps in each country: a stakeholder's analysis, an online survey and a focus group.

Materials and methods

Study areas

The study involved two study areas. The Carinthia is located in the southern part of Austria, in the Eastern Alps, bordering with part of the Italian study area, including part of the Veneto Region (the Province of Belluno and the mountain areas of the Province of Treviso and Vicenza) and in the mountain areas of the Friuli-Venezia Giulia Region.

The north and west of Carinthia (Hohe Tauern and Gurktaler Alpen) and the south of Carinthia (Gailtaler Alpen, Karawanken and Karnische Alpen) is dominated by mountain farming, which involves 63 % of farmers of Carinthia (Nitsch et al., 2014). The dairy cattle system is predominant in the study areas and is located mainly in the valleys silage maize cultivation, whereas grasslands are on the slopes. Permanent grassland represents the 75 % of the utilised agricultural area (UAA) and arable lands are the 25 % of UAA, mainly used to produce fodder crops including maize. A typical mountain farm of Carinthia keeps suckler cows with summering on alpine pastures (seasonal mountain pasture) for 90 to 120 days. The main challenge of the regions' future is a stable economic development since the rural areas are affected by depopulation and many farmers are concerned how to ensure a sufficient income (Nitsch et al., 2014).

As a result of the abandoning and intensification processes that affected all the Alpine agriculture, in the eastern Italian Alps cattle farms decreased by 45% from 1990 to 2010; the number of animals decreased much less (-18%), and hence herd size increased by 49% These trends were much stronger in the decade 1990-2000 than in the following one. In addition, they differed greatly within the area, and the abandonment was particularly strong in Belluno Province and in mountain areas of Friuli Venezia Giulia. Cattle farming is now largely

predominant over sheep and goat farming. The cattle farms can now be classified into a variety of systems, which represent different steps in the shift from the original, seasonally transhumant system based on the use of local forage resources with autochthonous breeds to a modern, intensive system with highly specialized breeds fed total mixed rations and concentrates (Ramanzin et al., 2014; Sturaro et al., 2013). In general, the changing from a forage-based dairy system towards a more intensive and non-seasonal systems has brought to a decrease in grassland of 27% and to the abandonment of local dual purpose breeds (Sturaro et al., 2013).

Preparatory phase for the focus group: snowball sampling and online survey

All activities were closely coordinated between the study areas by the University of Padova and by the Carinthian Chamber for Agriculture. All the steps of the analyses have been developed together in English and applied in the study areas translated in the official languages (Italian and German). The choice to realize two distinct focus groups, one in Carinthia and one in Veneto-Friuli, was based on the difficulties caused by the different languages and the different organization of livestock sector. In fact, the role of the moderator is fundamental in this kind of methodological approach. and the two moderators collaborated to develop common guidelines.

First, we performed a stakeholder analysis to identify all the stakeholders likely to affect or to be affected by the study. An “informal “method to reach the target population is the snowball sampling, a non-probability sampling technique where existing study subjects recruit future subjects from among their acquaintances (Atkinson and Flint, 2001). Thus the sample group is said to grow like a rolling snowball. However, the success of this technique depends greatly on the initial contacts and connections made. Thus it is important to correlate with those that are popular and honourable to create more opportunities to grow, but also to create a credible and dependable reputation. The grid presented in the Appendix A (List of Stakeholders) is called “name generator grid” and was used for the snowball sampling. The respondents had to specify in the grid the list of subjects that they considered as possible stakeholders for the project, separating them into four categories: i) stakeholders of the sector (producers, cooperatives, sellers, etc.); ii) policymaker (town, mountain communities, etc.); iii) local community (local action groups, associations, individual citizens, etc.); workers in the tourism sector (food service, touristic facilities, etc.). They were also required to suggest which of them were most suitable to take part to the preliminary stage of the

participatory consultation, as deemed most representative of the industry or of the institutions operating in the territory, assigning them a score of the subject importance, called reputational power. First, the scientific coordinators of each study areas filled up the grid. Then, an invitation mail to the study was sent to each of the identified stakeholders, asking them to fill up the name generator grid. As soon as a stakeholder sent back a completed list, an invitation mail was sent also to the newly suggested stakeholders. After a month, we had 75 stakeholder's contacts for the Italian study area and 25 for the Austrian one.

Then an online survey (Table1) was established using the platform SurveyMonkey Inc (San Mateo, California, USA, www.surveymonkey.com). The questionnaire aimed to discover what they knew about the Ecosystem Services (ESs) and what influence an animal husbandry can have in their opinion on a list of ESs. They were asked several other questions made for investigating their opinions on the relationships between the livestock system and the mountain agroecosystem and economy, to allow them to reflect on the subject and to help us to structure the focus group.

Table 1. Structure of the online questionnaire on SurveyMonkey Inc.

Questions Section: Ecosystem Services	**Answers**
Could you give a definition of "Ecosystem Services"?	Yes, I could I know roughly the meaning I heard about this concept, but I don't know the meaning I never heard about this concept
If you had chosen the first or the second answer, please try to define the term "Ecosystem Services".	Open answer
Section: Mountain food chain and Ecosystem Services	
The livestock sector has impacts on ESs. According to your opinion, it produces a negative or a positive impact on the following ESs? (the complete list of the ESs is in Results, Table 6)	Likert scale from -3 to +3. -3 = very negative impact; 0=no impact; +3= very positive impact Option "I don't know" included.
Section: Additional value	
According to your opinion, the livestock food production chain helps the maintenance of a mountain economy?	Open answer
According to your opinion, having a farm located in a mountain area is an added value for the food production chain?	Open answer
Communication	
Is the relationship between the food production chain and the added value coming from the location of the production in a mountain area adequately communicated?	Open answer
If yes, in which way?	Open answer
If no, why?	Open answer
What would you suggest?	Open answer

Focus group

Using the results of the two online surveys, we created a common design for the focus groups. Each study area had a mother language moderator. They constantly confronted and coordinated to ensure the best similarity possible for the two enquires.

A focus group is a planned discussion among stakeholders facilitated by a skilled moderator. It is designed to obtain information about people's preferences and values on a well-defined topic and why these are held by observing the structured discussion of an interactive group in a permissive, non-threatening environment (Elliott et al., 2005). It is a depth interview of a small group of persons (4-12), where the focus is not anymore the individual while the group opinion. The idea is to keep the group small enough to allow everyone to speak, but large enough to capture a range of views and experiences. In this study, we performed two focus groups, one for each study area, based on the results of the online survey conducted in the previous month and addressed to the same target groups. The focus groups lasted 1 hour and 45 minutes each. They were managed by a moderator and two assistants, which had to observe and take notes of the speech of the participants and of their body language. The meetings were also video recorded. Focus group was held in Italy with 11 stakeholders and in Austria with 8 stakeholders (Table 2).

Table 2. Final composition of stakeholder's focus group for Austria and Italy

Categories of stakeholders	**Austrian stakeholders**	**Italian stakeholders**
Stakeholders of the sector (producers, cooperatives, sellers, etc.)	6	2
Policymaker (town, mountain communities, etc.)	1	4
Local community (associations, individual citizens, etc.)	0	4
Workers in the tourism sector (food service, touristic facilities, etc.)	1	1
Total	8	11

The session was split into 4 parts, each one with a dedicated time to make sure all aspects were covered and avoid redundancy in the discussion (Table 3). First, an introduction was made, including the presentation of the objectives of the project, the content of the workshop, the rules of participation, and a brief self-introduction of participants. Second, a brainstorming was held on the added value of the mountain ecosystem on the local chain production system and the impacts of mountain farming on ESs. Next, using the online questionnaire results, a focus on the impacts on ecosystem services was made. Finally, stakeholders had the chance to discuss the strength and weaknesses of the present communication of all these topics. The translation of the results into English was produced by the moderators and assistants of the focus group to facilitate the comparison.

Table 3. Leading questions of each session of the focus group.

	Topic	Comments	Leading questions
Session 1 (15 minutes)	Introduction	Project Background and research topic Online survey results and common jargon Practical Information and "rules" of participation	Welcoming and Short introduction of the project Presentation on main results and key definitions The rules of participation given by the facilitator: levels of participation, all opinions and perspectives are important, respect of group dynamics, respect of timesheet, and the use of materials. An audio and video recording will be made for later processing, but all information gathered will be treated anonymously.
	Participants introduce themselves	Name, profession, relation to the topic.	We start with a short introduction. Tell us about yourself: name, occupation, and relation to our topic.
Session 2 (30 minutes)	Added Value of the mountain ecosystem on the mountain chain production system and impact from mountain farming to mountain ecosystems	Discussion using post-it: each participant gets 6 post-it cards in two colours); participants write down short statements and present their comment; facilitator groups cards by similarity on a flip chart.	Which is the added value of the mountain supply chain towards ES? Which is the added value of mountain area towards supply chain?
Session 3 (30 minutes)	Ecosystem services and mountain farming	Results from the online survey on a poster. Ranking with the group	Do you agree with the present ranking? If not, please provide a new ranking
Session 4 (30 minutes)	Recommendations on Communication of added value	Open discussion	Starting from the added values: I) Is the added value of the mountain understood by those who work in the supply chain? II) How is it currently communicated? III) What are the suggestions for the future? Do you think that labelling could be a solution?

Results

The online surveys

Concerning the Italian online survey, 75 people have been invited to participate by email. We collected 14 complete answers and 3 partial answers to the questionnaire. In Austria, 13 people completed the survey out on 25 invitation sent. A high percentage of the stakeholders answering to the questionnaire (1/3 Austria; almost 1/4 Italy) stated that they could give a definition of ESs (Table 4). The majority of Austrian stakeholders have already heard of this concept, but they don't know the meaning. In Appendix B are reported the tables with the

complete definitions of ESs and the complete answers to questions n° 7, 8 and 9 of the online questionnaires. Italian stakeholder's majority declared to know roughly the meaning of ESs. Austrian attempted to define ESs including short definitions focused on the concepts of services provided by nature for humans (Table 5). One stakeholder defined the ESs as "food". Italian definitions were longer and associated more the ESs concept with the maintenance of the environment than with the benefits for society. In few cases, they used very precise words inked to the actual definition of ESs (externalities, market price).

The ranking the positive impacts of the livestock sector was very similar between the study areas, especially concerning the top 4 (Table 6). Italian stakeholders pointed out three ESs for whom the livestock sector had a negative impact, whereas Austrian stakeholders signed no negative impact. However, the "GHGs emissions" scored close to the null impact for the Austrian stakeholders. In general, the perception of the impact of the livestock sector was very positive.

Table 4. Results of question n° 1 of the online questionnaire for Austria and Italy

Could you give a definition of "Ecosystem Services"?	**Austrian answers**	**Italian answers**
Yes, I could.	31 %	23 %
I know roughly the meaning	15 %	41 %
I heard about this concept, but I don't know the meaning	46 %	12 %
I never heard about this concept	8 %	24 %

Table 5. Frequency of sets of words used to define the ESs

Stakeholders wording	**Frequency**	
	Austria	**Italy**
Maintenance/conservation/safeguarding	0	4
Ecosystem/nature/environment/flora & fauna	3	7
Services/goods/benefits/ resources/gift	4	9
Man/humanity/community/society/mankind	4	4
Market price	0	1
Externalities	0	2
Food	1	0

In both study areas, the majority of stakeholder's thought that the livestock production chain helps the maintenance of a mountain economy and that having a farm located in a mountain area is an added value for the food production chain (Table 7). They also agreed on the fact that this relationship is not adequately communicated.

Italian stakeholders attributed lots of the difficulties in the communication to the lack of knowledge of the consumers of the characteristics of the mountain livestock production systems (Table 8). Besides, stakeholders highlighted a lack of strong associative realities

among producers and of investments in term of time and resources dedicated to the solution of the problem. Instead, the problem with the Austrian communication was that it was inconsistent, not well focused on defining the concepts and on promoting the awareness of the consumer. Moreover, they stated that there wasn't an association of small producers able to compete with the strong communication of the intensive livestock system.

In both study areas, the main suggestion was to improve the communication through a stronger and clearer information campaign, which could increase consumer's awareness (Table 9). They also both stressed the importance of involving children and of the necessity of a collaborative effort among stakeholders, whether private or public. Few Austrian respondents addressed the issue of public support, wishing an increase for the mountain farming, without impairing at the same time farmer's images. The Italian stakeholders suggested involving consumers in a direct experience of the livestock farming in the mountain, with interactions with the farmers. They also evidenced the need of a scientific and systematic research in the analysis of different strategies developed ad hoc for the different mountain realities.

Table 6. Online survey. Question n° 3. Impacts on ESs, in a scale from -3 to +3 (-3 means „very negative impact"; 0 indicates "no impact; 3 means „very positive impact"). The option „I don't know" was included, but no one of the respondents used it

The livestock sector has impacts on ESs. According to your opinion, it produces a negative or a positive impact on the following ESs?	**Austrian average (n =13)**	**Austrian ranking**	**Italian average (n=14)**	**Italian ranking**
Control of encroachment of shrubs and forest on pastures and meadows	2.60	3	2.64	2
Maintenance of beautiful natural landscapes	2.50	4	2.50	3
Maintenance of traditional cultural landscapes	2.70	2	2.38	4
Maintenance of a high biodiversity (diversity of plants and animal)	2.40	5	1.23	8
Maintenance of a suitable habitat for the conservation of wild animals	1.00	12	1.08	9
Maintenance of soil fertility	2.20	7	1.93	6
Prevention of soil erosion	1.90	8	1.07	10
Prevention of avalanche risk	1.50	9	1.00	11
Maintenance of cultural heritage	2.30	6	2.29	5
Maintenance of tourism attractiveness	2.70	2	2.79	1
Production of high quality foods	2.90	1	2.64	2
Maintenance of water quality (nitrate emission)	1.10	11	-0.62	13
GHGs emission	0.20	14	-1.38	14
Respect of animal welfare	1.90	8	1.38	7
Avoid soil compaction	1.30	10	1.07	10
Maintenance of air quality (smell)	0.90	13	-0.31	12

Table 7. Results of question n° 4, 5 and 6 of the online questionnaire for Austria and Italy

According to your opinion, the livestock food production chain helps the maintenance of a mountain economy?	**Austrian response**		**Italian response**	
	Percentage	**Number**	**Percentage**	**Number**
Yes	100 %	13	100 %	14
No	0 %	0	0 %	0
According to your opinion, having a farm located in a mountain area is an added value for the food production chain?	**Austrian response**		**Italian response**	
	Percentage	**Number**	**Percentage**	**Number**
Yes	92 %	12	100 %	14
No	8 %	1	0 %	0
Is the relationship between the food production chain and the added value coming from the location of the production in a mountain area adequately communicated?	**Austrian response**		**Italian response**	
	Percentage	**Number**	**Percentage**	**Number**
Yes	8 %	1	14 %	2
No	92 %	12	86 %	12

Table 8. The frequency of concepts used by stakeholders to explain problems in the communication of the relationship between the food production chain and the added value coming from the mountain production system. Question n° 8, online questionnaire

Stakeholders wording: problems in the communication	**Frequency**	
	Austria	**Italy**
Insufficient consumer's knowledge/ promote consciousness and awareness	2	6
Insufficient consumer's interest	0	1
Poor communication systems/lack of resources	0	2
No consistent/defined communication	4	0
Lack of strong associations	2	3
Lack of time	0	1
Competition of the industrial livestock system	2	0

Table 9. The frequency of concepts used by stakeholders to give suggestions to solve the communication problems. Question n°9, online questionnaire.

Stakeholders wording: suggestions?	**Frequency**	
	Austria	**Italy**
Stronger/clearer/ awareness raising consumer information campaign	9	8
Consumer direct experience	0	2
Scientific research/ analyse strategies for different productions/define development systems	0	3
Involve the youngs	1	2
Public and private/ stakeholders collaboration in the promotion	2	2
Economic public support to the mountain farming (subsidies)	1	0
Reduce negative image of farmer as cashing subsidies	1	0

Focus Groups: Italian stakeholders

Session 2: added values from ES on mountain farming and vice versa

Added values from ESs on mountain farming

After the introduction phase (Table 3), the participatory dynamics started with a brainstorming on the added value of the mountain ecosystem on the local chain production system and the impacts of mountain farming on ESs. The main added values resulting from the debate encouraged by the facilitator could be resumed in four clusters. The first, “Healthiness of the environment”, concerned the environmental characteristics of air, soil and water which make the environment healthy and the ecosystems rich in biodiversity. Landscape and wide spaces are further elements that improve the consumer’s perception of the final product. The second cluster, “Quality and taste of the final product”, addressed the availability of healthy raw materials which was recognized to facilitate the adoption and management of organic farming and to enhance the taste of the final products. The cluster “Social aspects related to tradition and culture” regard the importance of the passage down of traditional knowledge and of the valorisation of the role of the cheesemaker and of the farmer, which foster the cultural identification and the local population pride for their products. Finally, stakeholders addressed the topic of the “Consumer’s perception”. Within a niche market, the perception of the final consumer is influenced by the presence of the mountain, which is synonymous with purity in the common imagination. According to the participants, the buyer is more willing to buy a product that originates from a healthy environment, whose raw materials are “natural”, and which enhances traditional manufacturing. In the discussion were also reported the difficulties of production in a mountain environment, such as the inability to meet any demand growth, the uniformity of quality standards of organic farming, youth migration and the consequent aging of the population, which leads to lose traditional oral knowledge, unfavourable atmospheric, logistic and orographic characteristics of the territory. However, these problems can be transformed into opportunities for a proper product communication that enhances the presence of the mountain as a quality element.

Added values from mountain farming to ESs

The added value of the economic chain on mountain ES can be summarized into three macro categories. The first, “Landscape maintenance”, involved the effect of human work on the valorisation of areas that would be abandoned due to climatic and orographic adversity. This is possible through the constant cleaning of the territory, the mowing of meadows and the rational use of pastures. The second category was the “Territory conservation” from an ecological and hydrogeological point of view. Restoring abandoned environments favours both flora and fauna biodiversity. The third category was the “Economic push” for the territory, which came from the creation of employment and income, both directly through the supply chain itself, and indirectly with tourism. Demographically, this implies an arrest of depopulation and ageing.

Session 3: Added value from the supply chains towards mountains and its ESs

In the participatory session, the facilitator used the results of the online survey as the basis for the discussion. In this phase, participants had the opportunity to discuss the average score obtained by each ES in terms of impact, and change the order of the ES creating a new ranking. The question was on which is the impact of mountain farming on the mountain and its ESs. To facilitate the interpretation of the graph resulting from the online survey, the list of ESs was split into 4 intervals, which have been used to categorize impacts (high positive impact, positive medium impact, small positive impact, negative impact). Participants were asked to freely discuss each ES and to confirm their position into the ranking or to change it. Each change was discussed and agreed by all the experts. The results of the two consultation phases (the online questionnaire and discussion in the focus group) are listed in Table 10. The expert's group confirmed most of the impacts on the ES and created a fifth group inserting those ESs that are not touched by the presence of mountain farming.

Table 10. Summary of the two consultation phases (the online questionnaire and discussion in the focus group)

Online questionnaire ranking			**New ranking agreed in the group discussion**		
High positive values: from 2.5 to 3	1°	Maintenance of tourism attractiveness	1°	Maintenance of tourism attractiveness	High positive impact
	2°	Control of encroachment of shrubs and forest on pastures and meadows	1°	Control of encroachment of shrubs and forest on pastures and meadows	
	3°	Production of high quality foods	3°	Maintenance of traditional cultural landscapes	
Medium positive values: from 1.5 to 2.5	4°	Maintenance of beautiful natural landscapes	5°	Maintenance of beautiful natural landscapes	
	5°	Maintenance of traditional cultural landscapes	5°	Production of high quality foods	
	6°	Maintenance of cultural heritage	6°	Prevention of soil erosion	Medium positive impact
	7°	Maintenance of soil fertility	7°	Maintenance of a high biodiversity (diversity of plants and animals)	
Small positive values: from 0 to 1.5	8°	Respect of animal welfare	8°	Maintenance of a suitable habitat for the conservation of wild animals	Small positive impact
	9°	Maintenance of a high biodiversity (diversity of plants and animals)	9°	Respect of animal welfare	
	10°	Maintenance of a suitable habitat for the conservation of wild animals	10°	Prevention of avalanche risk	
	11°	Avoid soil compaction	11°	Maintenance of cultural heritage	
	12°	Prevention of soil erosion	12°	Maintenance of air quality (smell)	Null impact
	13°	Prevention of avalanche risk	12°	Avoid soil compaction	
Negative values: from -1.5 to 0	14°	Maintenance of air quality (smell)	12°	GHGs emission	
	15°	Maintenance of water quality (nitrate emission)	12°	Maintenance of soil fertility	
	16°	GHGs emission	16°	Maintenance of water quality (nitrate emission)	Negative impact

In particular, the supply chain has strong positive impacts on maintaining tourism attractiveness, which combines the issues addressed in the previous workshop of objective quality of products and the perception that the tourist has of the product itself and the surrounding environment. This ES is at the top of the ranking of impacts because both internal and external experts agree with its importance. Equally important, the control of the reforestation of meadows and pastures which, strongly linked to tourist attractiveness, generates the following impacts. Experts emphasized that reforestation does not happen through direct human intervention, but it is controlled through grazing animals that maintain a balanced natural reforestation. The first two ESs are followed by maintaining a traditional landscape linked to local culture. Next, maintaining a pleasant natural landscape, which

enhances tourists perception, and producing high-quality foods, to which most ES linked to tourism and perception derive, were considered at the same level.

The second interval of impacts on mountain ESs concerned first the prevention of soil erosion, which deserved a higher position than the one previously indicated in the online questionnaire. Maintaining a high biodiversity, moved to a higher position in the ranking because grazing allows the reduction of forest expansion and consequently the increase of flora and fauna species. Further, the connection with bees has been examined in depth as, thanks to the diversity of mountain flowers, they produce high quality honey with specific organoleptic characteristics.

Minor impacts, but still positive, concerned the maintenance of the habitat suitable for wild animals conservation, supported by the control of the reforestation of meadows and pastures. In addition to maintaining the habitat, it has been emphasized that there is also a preventive control of the damage caused by wild animals. Overall, experts judged positively the impact on animal welfare. This ES lead to a provocative question, which was whether or not an animal would be happier in the mountain environment. Well mowed meadow or were considered to have a slight positive impact on the avalanche risk prevention. It followed the maintenance of the cultural heritage, which exists and characterizes the mountain even if it is influenced by many other factors more important than mountain farming. Mountain farming allows people to work in the mountains reducing the population decrease, and at the same time maintaining some traditional practices, even if these techniques are not the same of fifty years ago. The cultural heritage must be seen as the possibility by locals, even though public contributions, to carry on a cultural identity that would otherwise be lost if only external workers are attracted.

According to participants, mountain farming had neither positive nor negative impacts on the soil fertility, which is not as relevant as previously highlighted in the online survey, as no cause-effect relationship has been established with mountain farming. No links were identified also with the prevention of soil compacting, with air quality and with greenhouse gases reduction, which cannot be influenced by the supply chain as the mountain environment is too broad.

The only ES which was subjected by negative impacts was the maintenance of water quality. Experts considered that the greatest risk for the ES is the nitrate release.

Session 4: Communication of Added Value

In the last workshop, the discussion topic concerned the producer's perception on the added values given by the mountain territory and their communication to the final consumers. Three leading questions were proposed during the debate by the facilitator (Table 3).

The first question asked if the added value of the mountain was understood by those who work in the supply chain. Experts said that the value was only partially understood by the operators. There was an awareness of the high quality of the products, however, it resulted difficult to place it on non-local markets because there was a lack of a strong identity associated with the production area. In a very independent way, every small producer tried to promote his own work, fearing that a collective promotion of the territory will not value his productive identity. Anyway, the livestock supply chain was the one that provided the highest economic margin in the Eastern Italian Alps. Experts stated that the quality and variety of its products, in particular cheeses, would deserve a better promotion. A focus on creating a mountain identity was felt as necessary. Several tools, quality labels for example, could help in this task. However, it was considered fundamental that the local population believed it more than the political decision-makers or producers themselves. The base concept was that it is difficult to generate added value if the local people do not promote their own products. Final consumers and the tourists who travel in the territory must believe in the sincerity of the product they consume. All inhabitants should know and recognize themselves in the area where they live: this would be the best and most effective advertising.

The second question aimed to explore how this added value was actually communicated. Experts said that it was not jointly communicated and the advertising didn’t go beyond the territorial boundaries. The local market remained the main reference for the individual producers, which were busy to compete among each other. Even if there was the awareness that added value could be achieved at an extra-territorial level, a typical mountain producer would struggle to find new markets where to sell. The outbound opening would also create a tourist flow: the product would thus become one of the main motivations for attraction to the area. The approach to connect the products to the territory in order to sell the added value of the mountain region, was already successfully adopted by other products categories, such as wine. What is more, labels such as “Verified Quality” did not effectively work because they were not connected to a specific territory.

In addition to the fragmentation that characterizes this Alpine area, another communicative difficulty concerned the producer's expertise. Good communication cannot be improvised and should be carried on by professionals. The global market requires the farmer to be also an

entrepreneur of himself, but small producers do not have enough skills and time to do it. To better address this issue, small produces need cooperation to put together different skills. Associations could bring benefits to the whole area, following the slogan "The success of my company is the success of my community". experts strongly stated that cooperation was indispensable, whatever its form.

An objection raised during the workshop concerned the production amount of the mountain farming. Small producers often referred to niche markets because the quantity produced would fail to meet a wider market. From this point of view, the risk of good promotion would be to promote products unable to satisfy the demand because of the limited productions. A reflection is needed to understand how to enhance the promotion of the mountain farming products without disregarding the expectations created by an intensive promotional campaign. The solution proposed by the experts considered a distinction between alpine and valley producers; having the last a higher production and currently placing the unsold at low prices.

With the third question, the adoption of a label linked to the mountain area was proposed as a possible solution. The first reflection concerned the fact that the European Community Regulation only refers to “Mountain Product”, while it would be necessary to distinguish “Alpine Product”, produced in mountain cottages, from “Mountain Product”, following the Switzerland model that was already implemented. The implementation only of the “Mountain Product” would risk to uniform producers with very different production levels and technical skills, making real the fear previously discussed of losing their own identity. Vice versa, it was considered important to avoid the creation of too many overlapping brands which would create confusion in the final consumer.

What is more, the “Mountain Product” existed at the regional level, but there was no precise regulation. Experts suggested that regulation of the label should come from the public decision makers. A suggestion was to make it easy to apply, otherwise farmers would not adopt it. One of the regulation requirements could be geographic, easy to assess by the farmers. Borders should be studied with experts and decided in a participatory way because an over-inclusive or too exclusive boundary could create conflicts and falling-out.

Another issue was the acceptance of the label by the local population. As discussed above, the entire territory should promote its products. Label implementation and information events must be carried out simultaneously. The requirement for a conscious consume would be to have a population aware of the contextual characteristics of the product. They were confident that the final consumer can be trained to quality.

The last idea emerged from the discussion involved the use of the wording "Mountain Product", accompanied by a sub-title that highlighted the productive features of each valley. The tourist or the external consumer would not be distracted by the overlapping of brands, but at the same time, this solution would meet the needs of each valley to promote certain typical products without losing the overall mountain identity.

Focus group: Austrian stakeholders

Session 2: added values from ESs on mountain farming and vice versa

Added values from ESs on mountain farming

As for the Italian case study, after the introduction phase the Austrian stakeholders were encouraged to debate on the added values coming from the mountain environment. The results can be summarized in four main clusters. In the first one, “Basis for traditional farming”, ESs are discussed as the basis for the feasibility of the extensive livestock farming system itself. The mountain landscape and environment improve the life quality of local people, sustaining also the local economy favouring the production of high quality products. This last concept was discussed further and can be synthesized in the “Production of high quality food” cluster. Mountain fodder is said to be of a higher quality and composed by different plant species, which makes it healthier for the livestock. A good animal nutrition enhances the taste of final products. Third, the “Diversity of the environment” cluster gather statements concerning the high animal, plant, habitats and landscape diversity that the mountain ecosystems offer as a richness for the production chain. Finally, the “Resource water” was treated as a separated issue, deserving a special attention. The great availability of clean water for animals, humans and the agricultural practices, is a great added value that the ecosystem provides freely to the farmers.

Added values from mountain farming to ESs

The added value of the mountain farming on the ESs can be synthesized into five categories of effects. First, “Biodiversity conservation” focus the attention on the maintenance and increasing action that livestock husbandry produces on the local biodiversity. The mowing of

meadows and pastures and the valorisation of areas otherwise prone to the abandonment, contribute to avoid the forestation of steeper areas. Second, livestock activities support the traditional “Cultural landscape” maintenance, linked to the identity of the local population. Third, mountain farming creates “Tourism attraction”, through making the landscape appealing and maintaining the recreational areas cleaned and mowed. Then, the category of “Protection of resources” grouped stakeholders opinions on the fact that the production chain contributes to the prevention of environmental hazards, like avalanches, and to the protection of soil. Finally, the “Maintenance of rural areas for mankind” it’s considered another important effect able to generate income in rural areas, to maintain living space for the local population. Health and active rural areas are seen as the basis for the production of food in mountains regions.

Session 3: Added value from the supply chains towards mountains and its ESs

Conclusions of the second session have been used as a basis for the two following sessions. The procedure was exactly the same applied for the Italian focus group, explained above. Also, in this case, the graph resulting from the online survey was split into 4 intervals, which have been used to categorize impacts (high positive impact, medium positive impact, small positive impact, null impact). Participants were asked to freely discuss each ES and to confirm their position into the ranking or to change it. The expert's group confirmed all the ranking of the ESs resulting from the online survey without any change.

The supply chain and the production of high quality food are linked by a highly positive relationship. The ESs mentioned as the top 4 positive impacts reflect the categories listed in the previous session, confirming once more the expert's point of view on the priorities and of the positive effects of the supplying chain. An equally positive impact was detected on the maintenance of tourism attractiveness and on the control of encroachment of shrubs and forest on pastures and meadows, which is identified by the experts as the basis for the maintenance of biodiversity.

As a consequence, a number of other ES which scored as medium positive impacts, could be synthesized under these main two themes. No difference is seen between ESs as preserving traditional landscapes and preserving natural landscapes, which could be summarized into one ES. The maintenance of cultural heritage, of soil fertility and the respect of animal welfare, fell back to the medium positive impact category. Experts stated that also issue connected to the soil (prevention of soil erosion, avoid soil compaction) and prevention

of avalanches risk could be summarized under a single impact. In this way, the production chain is said to have a moderate to small impact on the soil structure. Next, the mountain production chain had small positive effects on the water quality. The maintenance of a suitable habitat for the conservation of wild animals and the maintenance of a good air quality are ESs on which there are small positive impacts. Greenhouse gas emissions are considered not relevant in mountain farming. The entire sector was considered to have no negative impact at all.

Session 4: Communication of Added Value

In the last session, the discussion topic concerned the producer's perception on the added values given by the mountain territory and their communication to the final consumers. The facilitator proposed during the debate three leading questions (Table 3).

The experts said that the added value of the mountain, within the concept of Ecosystem Services, was being promoted in other countries of the Alpine region. In fact, they had knowledge of projects that aim to strengthen the communication of ESs and of the product quality. In the context of globalization, it is all the more important to pay attention to regional aspects in the marketing of products from the mountain economy, stressing the unicity of products coming from the alpine pastures. Conveying to the consumer the message that products from mountain farming have the highest quality, would allow farmers to get higher prices.

All participants agreed with the results that the added value was not sufficiently communicated. Inherently, the problem that aroused in the discussion highlighted that the regional products were already advertised a lot by the media, but in an incoherent and overloading way that resulted in confusing the consumer. They stressed the necessity of a target marketing, created for those consumer’s groups who value the quality of the mountain products.

At the same time, they felt heavy the competition with international food groups, who tend to sell cheap food and rarely promote regional, high-quality products. Moreover, the sales and marketing in the supermarkets were sad to develop slowly. The great availability of industrial product is making difficult to reach the shelves of the big distribution. To solve this problem, experts proposed to display regional products should on dedicated shelves. In the past, there have been some very successful regional projects, which were always based on the commitment of the individual stakeholder.

A very clean and explicative label was considered to be very important for the marketing. In fact, labels as “Mountain product” or “Mountain economy” need a clarification on what the term encompasses, due to the large regional differences present in the Carinthia. Almost all the region could fall into the definition of “Mountain product”, but this does not highlight the unicity of the products coming from different slopes and valleys. Experts also recognized that this heterogeneity would make the marketing more difficult, and thus an umbrella brand is somewhat a necessity.

Continuing on the discussion of this topic, the participants were answering the last leading question, on what were their recommendations for the future and for a possible use of a label. Having said that the brand and the logo for Mountain products were already available, they stated once more that the including the criteria needed a further specification. The logo needs to stand up among the other and evidence the quality control. Further, they suggested that the messages on the quality and on the services related to the production chain would be conveyed through appropriated “stories”, in cooperation with the trade and gastronomy.

Communication should not be used for clichés which are not true to reality but to show the real everyday life in mountain farming. As an example, an actor should wear normal work clothes instead of traditional and not practical leather trousers. Moreover, the communication should address all the level of population, starting from the schools.

They suggested that the communication of small-scale production and processing chains should be supported more by the policy and subsidies. Regardless of an external support, stakeholders should support each other through the networking of active projects. In the networking of initiatives and projects, the trade (small merchants) and the gastronomy sector should also be involved. The potential of initiatives like delivery services, or weekly subscription for mountain products should be taken into account. The efforts have to focus on the wishes and needs of consumers, addressing in particular the right consumer groups (premium segment). Overall, the marketing as “Mountain product” was considered an opportunity for the production chain.

Comparison of the two focus groups

The experts of the two study area discussed the same main issues, giving an interpretation that presented many similarities and few differences.

In the Session 2 we treated the added values or the benefits that the mountain contest conveys to the local production. The Austrian cluster “Production of high quality food”

matches with the Italian “Quality and taste of final products”. They both focused on the healthiness of animal nutrition, which improves the animal well-being and finally enhances the taste and quality of the final product. Similarly, “Diversity of the environment” coupled with “Resource water” corresponded to “Healthiness of the environment”. A certain degree of similarity can be found also between the Austrian cluster “Basis for traditional farming” and the Italian “Social aspects related to the tradition and culture”. They both considered the social sustainability, but with a different shade. The first is focused on the quality life of the farmers, the other look at the farmer’s work as the very background for the identity of the local community. Besides, the discussion of the Italian experts addressed directly the topic of the valorisation of the “Consumer’s perception”.

It was possible to detect parallelisms also in the categories of added values from mountain to ESs. “Biodiversity conservation” and “Protection of resources” corresponded to the category of “Territory conservation”. They resumed the effects of human work on the protection of the territory from an ecological and hydrogeological point of view. “Cultural landscape” and “Maintenance of rural areas for mankind” matched in the contents respectively with “Landscape maintenance” and “Economic push”. Instead, the Austrian experts focused the discussion on making the landscape appealing specifically four “Tourism attraction”.

Session 3 generated two ranking of ESs (Table 11). Austrian experts confirmed the original one, whereas the Italian reconsidered all together every single ES, arranging them in a new position. At the end of both focus groups, 4 ESs among 16 reached the top of both lists, being proposed as the main positive impacts of the mountain farming.

Among the high positive impacts, production of high quality food reached the first position for the Austrian experts, whereas in Italy it was placed at the 5 place. The sequence of placement of the three following ESs matches for both study area: first, maintenance of tourism attractiveness; next, control of encroachment of shrubs and forest on pastures and meadows, and finally maintenance of traditional cultural landscape. The Italian stakeholders inserted this category also the maintenance of beautiful natural landscapes. Speaking of the ESs related to the landscape, in the Austrian focus group was expressed the opinion that those ESs could have been grouped into a single one. The same proposal was made for the ESs related to the soil.

Prevention of soil erosion and maintenance of high biodiversity were judged as a medium positive impact in both focus groups. Austrian experts put more ESs in this category, as the maintenance of beautiful natural landscapes, the maintenance of cultural heritage, the respect of animal welfare, and the maintenance of soil fertility. The others were considered small positive impacts except for the GHGs emission, which was the only ES not influenced by the mountain farming systems by Austrian stakeholders.

Instead, Italian stakeholders thought that there were more ESs than the GHGs emission in the list that had no connection to cause and effect with the production chain in the mountain. They put in this category also the maintenance of air quality, the prevention of soil compaction and the maintenance of soil fertility.

One of the biggest differences among the two ranking is that Italian stakeholders thought that at least for one ES, the maintenance of water quality, the production chain had a negative impact, due to the emission of nitrates in the water.

In the last session, the focus groups faced communication and marketing problems. Both topics created issues in both the study areas. The Italian focus was put on the lack of collaboration among producers, that undermine a good advertisement which the single farmer cannot improve by himself for lacking of resources, expertise and time. According to experts, this situation prevented the creation of a strong power in the market sector which would make easier for them to place their products on supermarket shelves. In Austria, there was already a certain degree of communication, but without a network among producers, it resulted incoherent and not targeted, confusing the final consumer. They wished for a network able to involve all the stakeholders of the production chain, from the farmer to the people working in the gastronomy, to compete with the competition of the industrial and international food producers.

In both focus groups, experts agreed on the possible advantages coming from the use of a label, assuming that the regimentation would be clearer and more specific. The label should have a well recognizable logo with a wording more characterising than “Mountain products”. The risk would be to level out all the too much all the specificity of the products, making difficult to involve the producers that greatly value the unicity of their products. However, a high heterogeneity could create too much confusion, making necessary to have a sort of umbrella brand. A possible solution to both problems was proposed during the Italian focus group: a label with a logo, the main wording “Mountain product”, and a little subtitle that specify the origin (a specific valley or a smaller area of production).

Table 11. Comparisons of the ranking of impacts on ESs.

Austria		Italy	
Production of high quality foods Maintenance of tourism attractiveness Control of encroachment of shrubs and forest on pastures and meadows Maintenance of traditional cultural landscapes	High positive impact:	Maintenance of tourism attractiveness Control of encroachment of shrubs and forest on pastures and meadows Maintenance of traditional cultural landscapes Maintenance of beautiful natural landscapes Production of high quality foods	High positive impact
Maintenance of beautiful natural landscapes Maintenance of a high biodiversity (diversity of plants and animals) Maintenance of cultural heritage Maintenance of soil fertility Respect of animal welfare Prevention of soil erosion	Medium positive impact	Prevention of soil erosion Maintenance of a high biodiversity (diversity of plants and animals) Maintenance of a suitable habitat for the conservation of wild animals	Medium positive impact
Prevention of avalanche risk Avoid soil compaction Maintenance of water quality (nitrate emission) Maintenance of a suitable habitat for the conservation of wild animals Maintenance of air quality (smell)	Small positive impact	Respect of animal welfare Prevention of avalanche risk Maintenance of cultural heritage	Small positive impact
GHGs emission	Null impact	Maintenance of air quality (smell) Avoid soil compaction GHGs emission Maintenance of soil fertility	Null impact
		Maintenance of water quality (nitrate emission)	Negative impact

Conclusions

The qualitative approach used in this study provided interesting results on the awareness of stakeholders on relationships between livestock chain and ecosystem services in mountain areas. The challenges that the livestock supply chain faces in a mountain environment from the productive point of view can be transformed into opportunities if communication takes place in a clever and focused way. According to the opinion of the experts involved in the study, the benefits from the mountain context are many, and concern both objective factors such as the quality of raw materials and of the final product, as well as subjective factors linked to local traditions and perception of the final consumer. The combination of a healthy and uncontaminated environment with culture contained within a product creates an emotional factor that can be communicated to the final consumer in specific niche markets.

The results of the online survey were confirmed in the focus group sessions. There was a high agreement among stakeholders on the main positive effects of the production chain on

the territory, whereas there was some discordance on eventual null or negative impacts. In general, there was a positive vision of the effects of the livestock production chain on the mountain environment and vice versa.

In general, the experts involved in the survey are convinced that the presence of traditional quality products can be a business card for the whole territory, and this is a fundamental point to address strategies aiming to improve the added value of mountain products. The entire population benefits from this: touristic attractiveness generates economic growth that translates into job opportunities for young people, maintaining local production traditions. Beyond the economic benefits, there are also the ecological ones: the livestock supply chain allows the valorisation of resources, environments and landscapes. The presence of human activity in lands that otherwise would be abandoned allows the preservation of the territory itself, with respect to both hydrology and biodiversity conservation.

Summing up, on the one hand, awareness of the quality of the product is needed, on the other hand, suitable communication competencies are necessary to explore more global markets. Obstacles faced individually are difficult to overcome, while group debate can tackle the main problems. Therefore, collaboration among stakeholders was highly suggested and wished by the participants of the focus groups. Since the study areas had common problems, an international exchange of experiences among producers could promote and expand the market, increasing the sustainability of the whole production chain.

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APPENDIX A

EXAMPLE OF NAME GENERATOR GRID :STAKEHOLDERS' LIST

The following grid, in technical terms called "*name generator*", will be used for the *snowball sampling*, to identify stakeholders in the most complete way and to assign them a *reputational power* (a score of the subject importance). Please, specify in the grid the list of the subjects that you consider as possible stakeholders for the project, separating them into the categories listed below. You are also required to suggest which of them are the most suitable to take part in the preliminary stage of participatory consultation, as deemed most representative of the industry or of the institutions operating in the territory.

Stakeholder (institution, company, cooperative association, etc.)	**Contact person** (Name and Surname)	**Official rank or status in the institution**	**Province** / City	**Telephone number** and/or **email**	**Importance of the subject [0-3]** (3 = essential 2 = important 1 = relevant 0 = not relevant)	**Motivations or notes**
Stakeholders of the sector (producers, cooperatives, sellers, etc.)						
Policymaker (Town, mountain communities, etc.)						
Local community (Local action groups, associations, individual citizens, etc.)						
Workers in the tourism sector (food service, touristic facilities, etc.)						

APPENDIX B

In Appendix B are reported the tables with the complete definitions of ESs and the complete answers to questions n° 8 and 9 of the online questionnaires

Table 1. Definitions of Ecosystem Services given by stakeholders in the online questionnaire.

In case you ticked options a. or b. (knowledge of the meaning), we would like to ask you to give a definition of "Ecosystem Services". Statements of participants:
AUSTRIAN STAKEHOLDERS
ES are services for society if used correctly
Services of the ecosystem for humans
Nature provides services to humans like bees that pollinate plants, plants produce oxygen, forests protect from avalanches and mudflows, nature offers space for recreation
Ecologically valuable food
Gifts from fauna and flora to mankind
ITALIAN STAKEHOLDERS
They are the „services" provided by natural ecosystems, which allow the maintenance of life on earth through the cycle of the nutrients, the purification of air and water, etc..
Services related to environment, ecosystem and land conservation
Economic benefits to humanity coming from the environment and natural resources
Activities of valorisation/safeguarding of a habitat that benefits the community
Services related to the ecosystem for its conservation
Positive externalities coming from ecosystems that do not have always a market price
Bond between man and nature
The ability of natural processes and components to provide goods and services that directly or indirectly meet the needs of man and guarantee the lives of all species.
Services linked to the production of positive externalities created by an ecosystem
They are goods produced for the benefit of human well-being: nutrition, energy, water supply, etc..

Table 2. Answers of questions n° 7 of stakeholders in the online questionnaire.

Is the relationship between the food production chain and the additional value coming from the location of the production in a mountain area adequately communicated? If yes, in which way?
AUSTRIAN STAKEHOLDERS
Generally positively occupied term
ITALIAN STAKEHOLDERS
Through the media
Using the appropriate communication tools (Internet, TV spots, radio spot, newspapers, material printing, participation in events, fairs, etc.)

Table 3. Answers of questions n° 8 of stakeholders in the online questionnaire.

Is the relationship between the food production chain and the additional value coming from the location of the production in a mountain area adequately communicated? If no, why?
AUSTRIAN STAKEHOLDERS
Industrial LW is in the forefront and is disproportionately promoted
A more intensive communication would promote awareness of the value of high-quality, healthy regional foods
Open question for me – how is mountain farming defined?
Communication is often not consistent
There is no lobby

I believe that the added value of domestic food is becoming more and more important
Play a very small role. Products in supermarkets do not come from mountain farming
Consciousness among in children and in schools is not sufficient - bad communication, bad marketing
Term "Alm = Alpine Pastures" is frequently abused
ITALIAN STAKEHOLDERS
The consumer is unlikely to know the technical differences and their different impacts between traditional mountain pastures and intensive lowland livestock
Because the consumer has no basis for understanding the reality
Because the consumer has not a real interest in mountain products and therefore it is not worth investing on it
It seems to me that we rely only on passing word among mountain enthusiasts ...
Difficulties in communicating with those who do not know the mountain and its difficulties
Nobody knows the products named “of mountain”, and the difference between farms and crops of flatland
In summary: lack of time for operators; lack of strong associative realities among producers; lack of specific knowledge and ultimately lack of resources.
Excessive pulverization of companies
Lacking of team building
Because it is not clear for people how animal husbandry is practiced in the mountains in reality. In fact, there are some business cases that show a lock of ES.
I myself answering the previous questions I did not know which of the local livestock reality take into consideration (method, management, size)

Table 4. Answers of questions n° 9 of stakeholders in the online questionnaire.

What would you suggest?
AUSTRIAN STAKEHOLDERS
Lower subsidies for industrial agriculture, higher subsidies for mountain farming
Generally speaking the communication for regional products should be strengthend, together with a link to products from mountain farming
Clear and consistent communication is needed, like: „mountain farming is the highest form of eco-products“
Awareness raising among population
Intensify direct marketing and producers should be part of marketing; more transparency about productions systems in the food chain; reduce image of farmers as cashing subsidies
Stronger marketing and awareness raising especially with big food chains
Awareness raising among children and their parents
Stronger communication of the added values from sustainable produced food – opposite to fast food
Communicate strengths of products from mountain farming – especially on the emotional level
Clear definition of products from alpine pastures – and protect origin
Better cooperation in marketing between producers, tourism, trade and gastronomy
ITALIAN STAKEHOLDERS
Consumer information campaigns
Bringing the consumer closer to the area experiencing directly the productive realities
Financing studies that scientifically demonstrate the highest nutritional value of mountain products
Promote the livestock chain also at cultural level in schools
Organize events in mountainous areas where farmers can dialogue with consumers
Be more sharp in the communication and clearer in the hardest aspects. We need to elevate our culture
Make this difference known
According to the different types of production (highland summer farms, small -sized cheese factory, large industrial transformation centres), different strategies could be adopted. Anyway, the first step is to share the criticalities and opportunities of every single productive reality
Added value should be constantly communicated through sector days in order to give an idea to

consumers of every age. Another initiative could be the involvement of young people in school age with initiatives that can make them known the mountain livestock sector and especially the work of a mountain farmer.
A collective action of promotion in tune between public and private stakeholders
Well defined duties for communication for anyone who will run an activity in mountain
Better communication, and to define development systems. Common vision, common strategies.

General discussion and conclusions

The Ecosystem Services framework has emerged as one of the most suitable methodologies to assess the sustainability of livestock production systems, being capable to take into account peculiarity of the studied systems at different scale, able to describe complex systems of ecological processes tightly linked with, affected by and affecting socio-economic systems. The complete assessment of all the aspects of the sustainability demand a wide range of approaches and expertise (Martín-López et al., 2014), that we applied in this thesis to provide a comprehensive assessment of the ESs provided by the dairy cattle systems in alpine areas. To face the heterogeneity in the values of the Total Economic Value (TEV) taxonomy and the various difficulty of estimation, it is possible to apply a wide range of economic valuation approaches (market, revealed-preference, stated-preference, benefit transfer, etc.), with techniques developed specifically for the few components (Rodríguez-Ortega et al., 2014). Even if some approaches can be used to estimate the monetary value of a wide variety of ES, as in Bernués et al. (2014), they have been usually applied to one or two ES. Nevertheless, most ESs assessments focus on the biophysical or on economic valuation (Nieto-Romero et al., 2014; Plieninger et al., 2013; Seppelt et al., 2011) and only a few take into consideration only the socio-cultural preferences of stakeholders using a non-economic approach (Martín-López et al., 2012; Menzel et al., 2010). The few socio-cultural valuations applied to livestock husbandry have mostly concerned the assessment of cultural ES (Hernández-Morcillo et al., 2013). There is a broad scenario of methodologies for the socio-cultural assessment of ES, such as such as consultative, deliberative and participatory methods (Christie et al., 2012; de Groot et al., 2010), each one with different and particular techniques. In general, more research has been done on provisioning ESs rather than supporting, regulating and cultural (Zhang et al., 2007). Moreover, the scale for a social sustainability analysis should be relatively small, at a local or regional level, as comparisons conducted in other studies on a broader scale showed that the effect of the country of origin counts more than the differences among stakeholders (Klopčič et al., 2017; Kuipers et al., 2017). Large-scale assessments may conflict with the findings of micro- or meso-scale datasets (Lambin et al., 2001). Since micro- or meso-scale datasets are specific to time and place, they do not impact on the global debate but they become relevant when developing a local land use policy.

Thus, this thesis aimed to assess the multifunctionality of the alpine dairy cattle system in the Alpine agroecosystem, integrating the ESs framework into socio-economic approaches (choice model) and participatory approaches (questionnaire and focus group), involving and

adding value to the all the categories of stakeholders concerned (common people, farmers, restaurant and hotel owners, etc.). The survey was conducted at different scales (farm, provincial, regional and international scale), taking into account also Ecosystem Disservices (EDs).

Hereafter each thesis's chapter has been discussed.

The first chapter addressed the sociocultural and economic values of ESs provided by Alpine agroecosystems, identifying local stakeholders perception of ESs and EDs delivered by traditional dairy farming and measuring the willingness to pay (WTP) that the local population and the general population assign to key ESs in a mountain area. The use of a stated-preference method, which is based on a hypothetical market created through people's expression of their WTP (Bernués et al., 2014), allowed to the estimation of the Total Economic Value (TEV) of a wide variety of ESs.

ESs considered in the study were the result of a sociocultural valuation (Alfnes and Rickertsen, 2011; Hensher et al., 2005). The most relevant ES for society in these agro-ecosystems were conservation of agricultural landscapes, maintenance of biodiversity and provision of high-quality local food products. Water quality was included as a key regulating ES (or EDS depending on the level of provision) as it was found to be the main EDS for non-farmer stakeholders. In facts, differences among groups of stakeholders were found, confirming the fact that the perceptions of ESs have been shown to vary according to socio-demographic factors and individuals' backgrounds (Lamarque et al., 2011; Martín-López et al., 2012; Plieninger et al., 2013). As for other studies, stakeholders had a general positive of the environmental outcomes of the mountain dairy livestock systems and of the grazing system. (Bernués et al., 2013; Lamarque et al., 2011; Oteros-Rozas et al., 2014). In this first phase, cultural ESs resulted very important for all stakeholders, which highlights the need to bring them to the fore in environmental planning and management.

The relative levels of importance given to the ESs differed across scenarios, highlighting increasing welfare gains linked to water quality, biodiversity and landscape while in shifting from the intensification-abandonment or current scenarios to the sustainable development scenario. In contrast with these patterns and with findings of other studies (Bernués et al., 2015, 2014), respondents declared only marginal welfare losses or gains in moving from the current scenario to that with a lower or greater availability of quality products. People seemed willing to compromise on the provision of quality food products, but not on the other ESs (especially regulating) when moving across policy scenarios. In fact, both populations assigned the highest importance to the regulating ES, water quality, to which corresponded a fifty percent of the TEV.

Besides, the TEV was more than four times higher than the annual cost in the current scenario, which was judged unacceptable at almost the same level as the abandonment-intensification landscape scenario. Society showed to significantly value public goods derived from alpine agroecosystems and to have concerns about the decline of regulating ESs, water quality in particular. These results suggest that It would, therefore, be possible to take action to support the dairy sector and promote its sustainability and that research and policy makers should focus on the delivery of regulating ESs and its relationship with livestock systems management and the agricultural activities in the territory.

As reported in the second contribution of this Ph.D thesis, social sustainability of mountain livestock farming was the focus of the analysis. We investigated farmer's goals regarding their life and their farm, and the connections between objectives and the actual farming practices that affect the land management and consequentially the delivery of ESs.

While in the previous chapter we had tackled the social sustainability at a society level (multifunctionality), here we investigated it at the farm community level (Guillaumin et al., 2007; van Calker et al., 2007; Van Cauwenbergh et al., 2007) applying a qualitative approach which imply the self-evaluation by the farmer (Vilain, 2008). Participatory approaches like questionnaires have already been applied successfully to uncover social information related to livestock farming systems (Willock et al., 1999a, 1999b).

Performing a PCA and then a cluster analysis, we found farmers differentiated according to their goals into three groups, labelled as "Diversification entrepreneurs" (cluster 1, 7 farmers), "Traditional farmers" (cluster 2, 14 farmers) and "Planner farmers" (cluster 3, 25 farmers). Each cluster had a different point of view on the importance of determinate goals for their farms, the first focusing on economic and social aspects, the second not taking into account diversification of activities or skills inside and outside the farm, and the third considering all goals important for a complete farm management.

Only three stated behaviours resulted significant among clusters, which differentiated a minority of farmers, cluster 1, from the rest. Thanks to management choices (reduction of the amount of concentrates per cow to minimize the costs and use on-farm resources) and the moderate investments on machinery and facilities in the past 5 years, they were allowed to take holidays, translating into actions their goals of life improvement for the family. In contrast, Cluster 2 and 3 invested in machinery and facilities improvement of the farms and did not take holidays in the past five years. This highlighted a trade-off between economic aspects and social goals which involve the 85% of the sample, potentially decreasing the sustainability of the system under a social point of view. Besides, we found that the variables that linked the farms to the territory differentiated better than behaviours the environmental

management of the three clusters. Traditionalist farmers presented a management in tune with their objectives, with a low stocking rate and a higher maintenance of open areas and meadows.

Previous researches on livestock systems highlighted the complexity of the decision-making processes of farmers (Darnhofer et al., 2010; Errington and Gasson, 1994; Gibon et al., 1999; Willock et al., 1999a, 1999b). The process of translating personal objectives into actions could be interfered by many issues, as for example the need of more time or economic resources. In fact, farmers could declare to pursue an objective and never had the chance to apply it in the past. As a consequence, we could detect few matches between declared goals and actual past behaviours, but we obtained information about the actions that farmers would be willing to apply.

The identification of the heterogeneity of farmer's goals and behaviours is a relevant starting point to uncover potential trade-off that impair the sustainable development of the mountain farming system. Moreover, information acquired can help to improve the design of agroenvironmental policies, which will be more likely to find farmer's support and thus which will more effective.

Since few socio-cultural valuations have been applied to livestock farming systems and mostly to assess only cultural ES (Hernández-Morcillo et al., 2013), in chapter 3 we delved into stakeholders mountain farming vision of ESs, using participatory approaches (questionnaire and focus group). The scale of the study was international (Austria and Italy) and considered the whole multifunctionality of the mountain farming agroecosystem, focusing on the dairy cattle production chain.

The survey involved stakeholders of the dairy livestock production chain in neighbouring mountain areas of Italy and Austria. First, we performed a stakeholder analysis to identify all the stakeholders likely to affect or to be affected by the study. four categories: i) stakeholders of the sector (producers, cooperatives, sellers, etc.); ii) policymaker (town, mountain communities, etc.); iii) local community (local action groups, associations, individual citizens, etc.); workers in the tourism sector (food service, touristic facilities, etc.). After the stakeholder's analysis, we performed an online survey and a focus group. The study was repeated identically for the Austrian and for the Italian study area.

The experts of the two study area discussed the same main issues, giving an interpretation that presented many similarities and few differences. In both study areas, the majority of stakeholder's thought that the livestock production chain helps the maintenance of a mountain economy and that having a farm located in a mountain area is an added value for

the food production chain. Concerning the benefits that the mountain contest conveys to the local production, both Italian and Austrian stakeholders focused on the healthiness of animal nutrition, which improves the animal well-being and finally enhances the taste and quality of the final product, and on the diversity and healthiness of the environment. They both considered the social sustainability, Austrian concerning the quality life of the farmers, whereas Italians speaking of the farmer's work as the very background for the identity of the local community. Besides, the discussion of the Italian experts addressed directly the topic of the valorisation of the "Consumer's perception". It was possible to detect parallelisms among the stakeholder's group also regarding the added values from mountain to ESs. They resumed the effects of human work on the protection of the territory from an ecological and hydrogeological point of view. Besides, they recognized benefits for the cultural landscape maintenance for mankind. Austrian experts focused the discussion also on making the landscape appealing specifically four tourism attraction.

There was in the complex a high agreement among stakeholders on the main positive effects of the production chain on the ESs, whereas there was a discordance on eventual null or negative impacts. At the end of both focus groups, 4 ESs among 16 reached the top of both lists, being proposed as the main positive impacts of the mountain farming: maintenance of tourism attractiveness; control of encroachment of shrubs and forest on pastures and meadows; maintenance of traditional cultural landscapes; and production of high quality foods. However, Italian stakeholders though that at least for one ES, the maintenance of water quality, the production chain had a negative impact, due to the emission of nitrates in the water. Nevertheless, all stakeholders agreed on the fact that this relationship is not adequately communicated. Besides, they expressed the need for cooperation among all the stakeholders of the production chain, to create a strong power in the market sector to face the competition of the industrial and international food producers.

All things considered, group debate allows stakeholders and researchers to improve the understanding of the relationship between human activities and the ecosystem (Chan et al., 2012) and also to identify intervention points for problem-solving (Martín-López et al., 2014, 2012). Moreover, communication of the concept of ESs should be forwarded by researchers and policy makers to inform society (van Oudenhoven et al., 2012), promoting at the same time the public participation, which is considered fundamental to the success of conservation policies (Fischer and Young, 2007). The addressing of the overall of sustainability issues requires combined monetary and non-monetary (biophysical and socio-cultural) methodologies of analysis, in order to assess the value of ESs for social well-being.

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Appendix I

This paper was presented at the 23nd Animal Science Days meeting in National Park BRIJUNI (Croatia) in 2015. At the congress, I presented the results of contribution in the Wolfalps project, which was part of the work in my first PhD year. This contribution is attached to the PhD thesis as supplementary material.

Wolf (*Canis lupus*) predation on dairy cattle in eastern Italian Alps

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Abstract

Natural wolf recolonization of the Alps brings the challenge to reduce livestock losses and social conflicts. In this study we examined the uncommon impact of a wolf pack on the cattle farming systems of the “Lessinia”, in the eastern Italian Alps. Dairy cattle farming predominate there, with use of summer pastures (June-September) and grazing on lowland meadows out of summer. Grazing is organized with aim to minimize labour and costs. Animals are usually left unattended during the day and night in unprotected pastures. Since the return of the wolf in 2012, which formed a pack in 2013, attacks to livestock increased

rapidly. Predations peaked during the summer, and they also were extended into the preceding and following months, especially during 2014. Cattle were the predominant species predated (79% of events and 71% of individual losses), with a strong selection towards young age classes. To prevent attacks, livestock should be grouped and kept protected by electric fences or in stables during the night, but this contrasts with the free-grazing management that farmers have adopted for reducing costs. We suggest that costs of management changes and of introduction of protection measures should be taken into account for a future economic valorisation of the cattle farming sector.

Keywords: dairy cattle, mountain, wolf, livestock systems, depredation

Introduction

The recent natural recolonization of many European areas by wolf has increased the conflicts with humans (Linnell and Boitani, 2012; Reinhardt et al., 2012). Conflicts arise particularly where farmers have lost the habit to protect their livestock, which are often left grazing unattended and unprotected, even at night (Reinhardt et al., 2012). Reducing the conflicts due to predation on livestock will therefore require changes in the farming practices and the adoption of protection methods (Dalmasso et al., 2012; Linnell and Boitani, 2012). In fact, damages compensation alone fails to reduce animosity towards wolves (Dalmasso et al., 2012; Reinhardt et al., 2012). Sheep and goat are the most frequently livestock species killed by wolves in Europe (Reinhardt et al., 2012), but predation on cattle may also occur (Dalmasso et al., 2012). In order to assess the feasibility of adoption of prevention methods on cattle herds it would be useful to focus on recently recolonized areas strongly committed to cattle farming. This is the situation of “Lessinia”, in the eastern Italian pre-Alps, where a wolf pair settled in 2012 and formed a reproductive pack in 2013. Predations on livestock raised in the farmers a strong objection and the willingness to get rid of wolves again. In this study, conducted in the context of the A7 action of the LIFE Wolfalps Project (WOLFALPS, 2015), co-financed by the EU, we present the farming and grazing systems in Lessinia, and describe the patterns of predations on livestock by the recently formed wolf pack. We then discuss the changes in farming practices, with the appropriate protection measures for reducing the impact of predations, and the cultural and economic difficulties to implement them.

Material and methods

Study area

The Lessinia is located in the eastern Italian pre-Alps. It includes 18 municipalities of the Verona province in the Veneto region and one municipality in the Trento Province, with a total surface of 689 km^2. Almost 100 km^2 are included in the Lessinia Natural Regional Park, which was established in 1990 by the Veneto Region. The area is mostly mountainous; the main villages are located on the slopes below 1200 m a.s.l., where forest patches and meadows are predominant land cover. Above this elevation, wide areas of grassland are used for livestock summer grazing. The potential wild prey for wolves are mainly roe deer (*Capreolus capreolus*) and wild boar (*Sus scrofa*). Alpine chamois (*Rupicapra rupicapra*) is present in habitats where predation is difficult, and red deer (*Cervus elaphus*) still has a very low abundance (Calderola S., personal communication).

Data collection and analysis

To describe the livestock farming and grazing systems in Lessinia we used data from Official Agricultural Censuses (ISTAT) and databases produced for previous studies (Mrad et al., 2009; Sturaro et al., 2014, 2013). We gathered information on predation events collected by the Veneto Region. Predation events were assigned to wolf based on an *in situ* inspection by trained personnel (at least two persons per event, in total 11 persons during 2012-2014) of the State Forestry Corp and the Lessinia regional Park. In the study area there are no other large carnivores, and stray dogs are absent. Information about the date, location, the owner of the farm/livestock, species of the prey, age and number of individuals injured or killed, was organized and analysed. We georeferenced the predation events (open-GIS software Quantum GIS) and calculated the size of the area where attacks occurred by the use of minimum convex polygon method (ArcGIS® software by ESRI). The frequencies of predation events among periods were compared using the Chi square test.

Results and discussion

Livestock farming and grazing systems

Dairy cattle farming largely predominates over sheep and goat farming in Lessinia (Table 1). Many small traditional farms have been abandoned and the intensification of production systems has led to an increase in the herd size in the period 1980-2010 (Table 1). Despite these changes, cattle farming in the area is still based on the use of meadows and pastures (Sturaro et al., 2014), especially during summer. Summer farms are located at an average elevation of 1462 ± 128 m, which allows long usage period (124 ± 9 days). The average size of pastures is 68 ± 38 ha and stocking rate is 0.96 ± 0.36 LU/ha (LU=Livestock unit). Composition of herds/flocks in summer farms is 43% dairy cows, 38% heifers and calves, 6% beef cattle (suckler cows with calves), and 12% sheep and goats (only 2 flocks). Summer farms are managed to reduce labour and costs as much as possible: the animals are left unattended and free to graze in unfenced areas during day and night, without guarding dogs (Mrad et al., 2009; Sturaro et al., 2013). Thanks to the very good accessibility (it is possible to reach 84% of summer farms by normal car), farmers make only short visits once or twice per day to check the animals or to milk them, but farmers usually (86% of the units) do not stay permanently with them. Many farmers use lowland meadows for a period of grazing, also unattended, before and after the summering season.

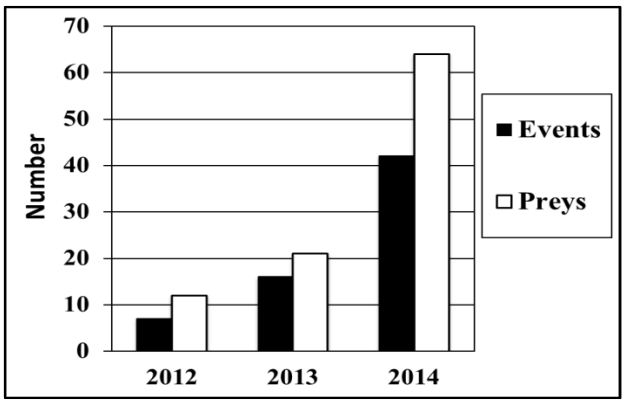
Table 1. Trend of the livestock sector (permanent farms) in Lessinia from 1982 to 2010 (ISTAT) (na = not available)

Farming systems	1982	1990	2000	2010
Cattle farms	2256	1661	983	656
Cattle heads	38952	40683	34335	26668
Dairy cows	16108	18558	15234	12072
Sheep and goat farms	na	na	237	142
Sheep and goat heads	na	na	2229	3117

Wolf Predation

Wolf predations on livestock first occurred during the winter 2011/2012, and since then increased rapidly (Figure 1). In 2014, 42 events and 64 livestock losses were observed. In addition, in this year the permanent farms, previously never attacked, suffered 10 predations on lowland meadows after the summering period, revealing that wolves began to follow the herds on their return the villages. The total surface (minimum convex polygon) affected by predation events was 26 km^2 in 2012, 33 km^2 2103, and increased to 105 km^2 in 2014. The distributions of predation events and of livestock losses (Figure 2) differed significantly between months (χ^2=37.5, P<0.001, and χ^2=54.3, P<0.001). Summer was the most dangerous period, although predations extended over the previous and following months. The median number of days between subsequent attacks decreased from 11 days in 2012 and 2013 to 3 days in 2014. The strong increase of predations after the wolf return happened in the area where livestock is managed without protection practices and the temporal pattern of predations peaking in summer are similar to those observed in other areas (Dondina et al., 2014).

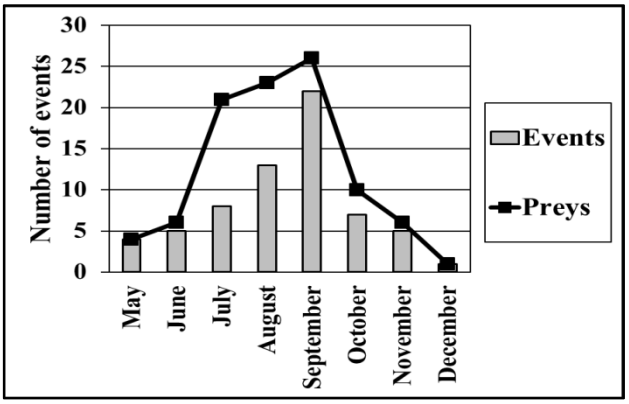
Figure 1. Total number of predation events and livestock losses in the Lessinia from 2012 to 2014



Attacks mostly occurred on cattle (79% of events and 71% of individual losses, secondly on equids (15% and 18%), and lastly on sheep and goats (6% and 11%). This pattern is unusual, since sheep and goats are the preferred domestic prey of wolf (Reinhardt et al., 2012), but it can be related to the very low availability of small ruminants combined with the lack of protection measures for grazing cattle. In such situations, predation on cattle may be remarkable (Álvares and Blanco, 2014). Wolf clearly exerted a selection for age classes of cattle predated: most of the attacks (77%) were on calves <1 year old (42 % on calves < 6

month of age). Yearling cattle were attacked less (21%), whereas individuals older than 2 years were avoided (2%), although they were almost half of the cattle grazing. This pattern is consistent with what observed in other areas (Dondina et al., 2014).

Figure 2. Monthly distribution of predation events and livestock losses in Lessinia from 2012 to 2014



In the farming and grazing systems of Lessinia there are many problems to be addressed in order to reduce the impact of the wolf predation. The most effective protection tools for livestock are electric fences and guarding dogs, especially for sheep and goat (Marucco and Boitani, 2012; Reinhardt et al., 2012). Dissuasive methods, acoustic or visual, are effective only temporarily and in specific situations (Reinhardt et al., 2012). Delimitation with permanent anti-predator fences of the rugged and wide pastures is impossible, because of the cost and impact on wild animal biodiversity and touristic attractiveness of the regional park. Experience of using guarding dogs with cattle is very limited in Italy, and in any case dogs may work only if livestock are not dispersed over wide pastures. Therefore, the only option to protect cattle in Lessinia is the night gathering within appropriate electric fences or stables. For making this feasible, however, farmers should abandon the practice of continuous free-grazing, adopting instead rotational grazing, which makes easier to group and protect the animals. However, single farmers cannot afford the additional costs of providing fences and water troughs to create pasture sections, and especially the salary for a shepherd to move the animals and to gather them before the night. An improvement in pasture productivity through a better management would not create a benefit for the farmers, because actual stocking rates are already lower than the pasture capacity and/or animal requirements are compensated with concentrate supplementation. These difficulties increase the negative attitude of farmers and other local stakeholders against wolf. Although the livestock losses are refunded by the regional administration and can be estimated at <1% of

the number of cattle present in Lessinia, intolerance towards the wolf is growing (WOLFALPS, 2015). Most of the farmers do not accept the idea of implementing livestock protection measures, even if publicly supported, because by applying them they would implicitly accept the presence of wolf. In this context, we suggest that the mitigation of wolf predation should be integrated into a comprehensive plan aimed at re-valuing the cattle farming sector in Lessinia, which is weakened (Sturaro et al., 2014) by the limited attitude of the owners towards innovating the farming structures and practices, the inadequacy of buildings and equipment in summer farms (Sturaro et al., 2013), and the low price paid for the milk sold to private dairies. For this purpose, opportunities are good (Sturaro et al., 2014), since the area has a high touristic attractiveness and the “Monte Veronese” local cheese is protected by a PDO, which could be used as a marketing tool. Therefore, the mitigation of the human-wolf conflict needs an effort of farmers and local stakeholders, supported by the regional agricultural policies, for a structural and technical innovation of the farms, a cooperative processing and marketing of milk to increase its value, and a diversification of incomes through agro-touristic activities. This might greatly increase the economic viability of farming, and then justify the complication in management and the increased costs of grazing management for protection against wolf attacks.

Conclusion

This study examined the uncommon case of predations concentrated on dairy cattle by a wolf pack recently established in an area with a high density of livestock. In absence of protection measures, predations are increasing, and this has shaped a strongly negative attitude of the local communities against wolf. The farmers are unwilling to modify the practices that they consider traditional in order to adopt adequate prevention measures for which they cannot afford the costs. Simply compensating the direct costs of such measures would not be acceptable in front of the indirect costs of the modified management practices. Therefore, the solution of the human-wolf conflict must be integrated into a global approach to innovate and sustain the livestock sector, taking advantage of the synergies with tourism and marketing that are now undervalued.

Acknowledgement

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Appendix II

This paper was presented at the 19th Meeting of the FAO-CIHEAM Mountain Pastures sub-network (14-16 June 2016). This contribution is attached to the Ph.D thesis as supplementary material.

Transhumance of dairy cows on alpine summer pastures: relationships between milk production, pasture management, and insect biodiversity

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Abstract

In the Alps, centuries of coexistence of human activities and harsh climatic and topographic conditions generated the alpine summer pastures agroecosystems, rich in biodiversity and cultural values. The maintenance of species-rich summer pastures and their ecosystem services is linked to the low-intensity livestock grazing. In this study we assessed the interactions between dairy livestock category/productivity, weed encroachment and butterfly biodiversity in 21 summer farms in the Trento province (Eastern Italian Alps), 16 with lactating cows and 5 with heifers. We collected data on milk production from May to October and Body Condition Score (BCS) at the beginning and at the end of the summering season for 799 lactating cows of different breeds. We assigned a subjective score from 1 (good conditions) to 4 (bad conditions) to different pastures sections based on the level of weed encroachment. Three plots per summer farm were surveyed three times for data on butterfly diversity. We analysed the interaction between month and breed on milk yield and BCS. Relationships between butterfly biodiversity, weed encroachment and other traits were investigated. We found that local and dual-purpose breeds perform better during the transhumance than specialized breeds. We found that category/productivity of livestock and stocking rate were non-related with pasture conditions index and that low stocking rates advantage butterflies. Our results suggest that the ability of local and dual purpose breeds to adapt to summer pastures conditions should be used to devise grazing management programmes to maximize the trade-off between pasture productivity and biodiversity.

Keywords: Highland pastures – Summer farms – Dairy cows – Grassland management – Insect biodiversity

La transhumance des vaches laitières en pâturages alpins d'été: relations entre la production de lait, la gestion des pâturages et la biodiversité des insectes

Résumé

Les agroécosystèmes des alpages offrent plusieurs services écosystémiques, qui ont été préservés grâce à l'usage de la transhumance. Le changement de cette pratique met en danger la conservation de ces écosystèmes. On a évalué les interactions entre les catégories et la productivité de bétail laitier, l'invasion des mauvaises herbes et la biodiversité des papillons dans 21 fermes d'été dans les Alpes orientales, dont 16 logeaient

des vaches laitières et 5 des génisses. Les données sur la production de lait ont été recueillies de Mai à Octobre, tandis que celles sur le Body Condition Score (BCS) de Jun à Septembre pour 799 vaches laitières de races différentes. Un score subjectif de 1 (bonnes conditions) à 4 (mauvaises conditions) a été attribué par différents secteurs des pâturages selon le niveau d'invasion des mauvaises herbes. Trois parcelles par alpage ont fait l'objet d'une enquête trois fois pour observer les papillons. Nous avons analysé l'interaction entre le mois et la race sur le rendement du lait et sur le BCS, et aussi les relations entre la biodiversité des papillons, l'invasion des mauvaises herbes et d'autres traits. Les races locales se sont révélées plus appropriées pour la transhumance. Les caractéristiques de gestion de bétail et le chargement ne sont pas liés aux conditions de pâturage, tandis que un chargement léger semble bénéficier aux papillons. La capacité des races locales à mieux s'adapter devraient être utilisée pour concevoir des programmes visant à améliorer le compromis entre la productivité du pâturage et la biodiversité.

***Mots-clés** : Pâturages alpins – Fermes d'été – vaches laitières – Gestion des pâturages – Biodiversité des insectes*

Introduction

For centuries mountain farmers have practiced transhumance of livestock in summer farms, which are temporary farms used in summer to incorporate the highland forage to the total amount of resources of permanent farms (Mack et al., 2013; Sturaro et al., 2013b). The extensive livestock systems contributed to generate semi-natural habitats that supply provisioning and non-provisioning ecosystem services (ES) and are classified High Natural Value Farmland (Rodríguez-Ortega et al., 2014; Strohbach et al., 2015). In the last decades, the mountain livestock systems experienced an abandonment process in marginal areas and an intensification trend in more productive areas (Bernués et al., 2011; MacDonald et al., 2000; Strijker, 2005), which deeply affected traditional summer farms management. In several cases lactating cows are no more moved to summer farms. On the other hand, highly specialized breeds are moved to highland pastures, requiring high levels of feed supplement to sustain their productivity (Sturaro et al., 2013a). The aim of the study was to assess the impact of transhumance on fitness condition and milk production of different cattle breeds, and to detect the relationship between different intensities of management on pasture weed encroachment and on butterfly diversity.

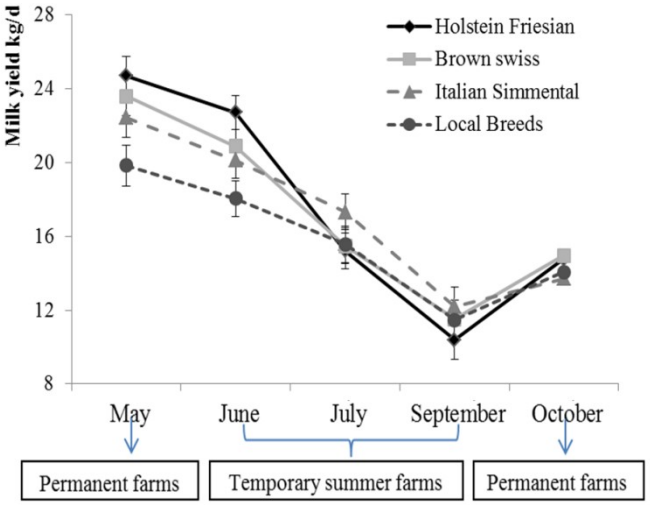
Materials and methods

The study was conducted in the Trento Province (north eastern Italian Alps). Almost all the permanent dairy farms of the province move their heifers to summer pastures, while only half move also lactating cows (Sturaro et al., 2013a). Ownership of summer farms is mainly public (usually district councils), and each summer farm normally hosts cattle from several permanent farms. This paper presents a synthesis of the results of a project (Cowplus) aimed at analysing the overall sustainability of summer farms. A Ph.D thesis was developed on this project (Zendri, 2015) and papers have been submitted to scientific journals (Jerrentrup et al., 2016; Zendri et al., 2016). The study involved 21 summer farms (average elevation of 1680 ± 307 m a.s.l.) with multi-breeds cattle herds during the summering season (mid June to September) of 2012. Five summer farms kept heifers (1756±366 m a.s.l.), and the other sixteen kept lactating cows (1657±295 m a.s.l.). Data on herd composition and milk yield were obtained from Provincial veterinary services and official recordings, whereas data on pasture area, pasture subdivision into sections and stocking rate were obtained through an on farm survey. We performed a two steps analysis. First, we analysed at the individual level the effects of transhumance on 799 cows of two specialized dairy breeds (90 Holstein Friesian, 314 Brown Swiss) and of two dual-purpose groups (241 Simmental, and 154 classified as “Local Breeds”, mainly Grey Alpine and Rendena). Body condition score (BCS) was collected by two trained operators in summer farms, in July and September, using a five-classes scoring (from 1, emaciated, to 5 obese) as stated by Edmonson et al., (1989) for dairy breeds. Milk yield was recorded in May (in permanent farms before transhumance), June, July and September (in summer farms) and October (in the permanent farms after transhumance). The BCSs and milk yields data were analyzed (MIXED procedure, SAS, Institute Inc., Cary, NC), with a model including the fixed effects of breed, month (and their interactions), the class of parity (2 classes) and the class of days in milk (5 classes) of cows, and the individual nested within summer farms as random effect. In the second step, we examined differences in weed encroachment and butterfly biodiversity of pastures. The different pasture sections were visited and a subjective score from 1 (good quality) to 4 (bad conditions) was assigned according to the level of weed encroachment. Data on butterfly diversity (Hesperioidea and Papilionidea) were collected three times during the summering season in a subsample of 15 summer farms. For each summer farm, three plots were selected: one next to the farm building (max. 50 m), and two at ca. 300 m from the farm building following random directions. The correlation among management data (stocking rate and feed supplement), weed encroachment index and mean butterfly species richness were tested.

Results and discussion

Figure 1 displays monthly least square means of milk yields of the different breeds, as reported by (Zendri et al., 2016). All breeds lost production during the summering season, despite of supplementary feeding, and recovered after returning to the permanent farms. This loss could only partially be explained with the advancing stage of lactation, and indicates that transhumance is a stressful challenge for dairy cattle, moved from constant shelter and diet to wearing outdoors living. In addition, while in May and June breeds were ranked according to their productivity (Holstein Friesian > Brown Swiss > Simmental > Local Breeds), in July differences were much smaller, due to a greater yield loss in specialised breeds, which was not recovered afterwards. This greater loss of specialized breeds confirms the results obtained by other studies (Horn et al., 2014). The BCS scores confirmed strong and expected differences among breeds (average values: from 2.54 for Holstein Friesian to 3.01 for Local Breeds). Differences between early (July) and late (September) summering season were however modest for all breeds. The stocking rates were lower in summer farms hosting heifers (0.86±0.53 LU/ha) than in those with lactating cows (1.10±0.56 LU/ha), which had a naturally lower weed encroachment (cows 2.83±0.38; heifers 3.17±0.51). Stocking rate, amount of feed supplement and weed encroachment were not correlated (data not shown in table), which suggests a disruption of the traditional link between herd average needs and intensity of pasture management. Sampled butterfly species were 70% sedentary (Jerrentrup et al., 2016). Low mobility makes sedentary butterflies more sensitive to changes in their habitats (Curtis et al., 2015). Butterfly species richness was higher far from the farm building for summer farms with lactating cows (close: 9.6±3.3; far: 18±7.6), whereas no differences were observed for summer farms with heifers (close: 10.4±5.8; far: 14±3.4). The lower species richness next to the farm building in summer farms with cows is most likely due to the adverse impact of an intense trampling and grazing on flower abundance and on the vegetation structure. This was not observed in summer farms with heifers, most likely because of the lower stocking rate and the ability of young cattle to distribute more evenly their grazing pressure over the pasture areas.

Fig. 1. Monthly least square means of milk yield of different cow breeds (Zendri, 2015).



Conclusions

The traditional link between pasture management and animals productivity has weakened in summer farms. The transhumance of specialized breeds, despite supplementary feeding, causes a strong reduction of milk yields, without improving significantly pasture conditions. A sustainable management of summer farms should focus on local or dual purpose breeds, more adaptable to the transhumance conditions. Summer pastures managed with moderate stocking rates of herds composed of local breeds would ensure a positive effect on butterfly biodiversity, without decreasing the milk yield, since local breeds adapt better to summering than specialized breeds.

Acknowledgments

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Appendix III

Curriculum Vitæ

Personal Information	
Surname	FACCIONI
Name	Georgia
E-mail:	georgia.faccioni@studenti.phd.it
Nationality	ITA
Birth date	19/04/1990
Education	
Date	12/09/2014
Title	Master degree
Final mark	110/110 cum laude
Title of the thesis	Carbon and hydric functioning recordings by sessile oak's (*Quercus petrae* Liebl.) tree-rings
Degree course	LM-75, Science and Technology for the Environment and Territory (D.M. 270/04)
University	University of PADOVA - Via 8 Febbraio, 2 – PADOVA (Italy)
Date	2012
Title	Bachelor degree
Final mark	110/110 cum laude
Title of the thesis	Role of the alpine summer pastures in the dairy cattle systems of Trento: management and relationship with the environment
Degree course	L-32 Science and Technology for the

	Environment
University	University of PADOVA - Via 8 Febbraio, 2 – PADOVA (Italy)
Experiences	
Period	01/11/2014 - today
Position	Ph.D candidate
University	University of PADOVA - Via 8 Febbraio, 2 – PADOVA (Italy)
Department	Department of Agronomy, Food, Natural resources, Animals and Environment
PhD course	ANIMAL AND FOOD SCIENCE

List of publications

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- G. Faccioni, R. Da Re, E. Sturaro. Report on the Focus Group Conegliano, 30 June 2017. Focus Group on Ecosystem Services and Mountain Farming. Project ITAT 2009 Top Value/ Interreg V-A Italy-Austria 2014-2020. 24p.

- Creation of the database and support for the analysis for core area 5 core area 6. Implementation of the joined general database of the project. Contribution to page setting and layout of the technical report. Project LIFE 12 NAT/IT/000807 WOLFALPS. Wolf in the Alps: implementation of coordinated wolf conservation actions in core areas and beyond. Azione A7 – Ex ante survey of damages caused by wolves to livestock and analysis of existing farming systems and vulnerability analysis in the Alpine core areas. Technical report